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Vol. XXIV April, 1948 No. 2

THE PAN-PACIFIC ENTOMOLOGIST

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CONTENTS

ESSIG, BIOGRAPHY OF SOL FELTY LIGHT 49
LIGHT AND WEESNER, BIOLOGY OF ARIZONA TERMITES 54
MACSWAIN AND LANHAM, NEW GENERA AND SPECIES OF PAUROPODA FROM CALIFORNIA 69
BODDY, CULICIDAE OF WASHINGTON 85
HOBBS, CLASSIFICATION OF TORYMUS 95
ROSS, EMBIOPTERA OF NEW GUINEA 97

San Francisco, California
1948

THE PAN-PACIFIC ENTOMOLOGIST

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Manuscripts for publication, proof, and all editorial matters should be addressed to the editors, 112 Agricultural Hall, University of California, Berkeley 4, California. All communications regarding non-receipt of numbers, changes of address, requests for sample copies, and all financial communications should be addressed to the treasurer, R. C. Miller, at the California Academy of Sciences, San Francisco 18, California.

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FOURTH SERIES

VOLUME XXIV

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The Pan-Pacific Entomologist

Vol. XXIV, No. 2 April, 1948

SOL FELTY LIGHT
1886–1947

BY E. O. ESSIG
University of California, Berkeley

Sol Felty Light was born in Elm Mills, Kansas, May 5, 1886. His father was a Presbyterian minister, and his maternal grandfather, J. W. McDill, was United States Senator from Iowa, a member of the U. S. Interstate Commerce Commission and U. S. District Judge. Thus his whole life was motivated by great ability, high ideals, strict honesty and real responsibility that helped to make him the great teacher and investigator that he was. Little information is available concerning his boyhood. His career began at his graduation with an A.B. from Park College, Parkville, Missouri, in 1908. Following graduation he taught English in the Government Schools in the Philippines from 1908 to 1909; was a teacher in the Manila High School, 1910-1911; and joined the staff of the University of the Philippines as an instructor in 1912. During 1912, also, he made an expedition to Puerto Galero, Island of Mindoro, to study the fauna there. He obtained his M.S. at the University of the Philippines in 1913. During the year 1914-1915 he took a leave of absence to become the Procter Fellow in Zoology at Princeton University for which he received another M. S. degree in 1915. Returning to the University of the Philippines he became successively, Assistant Professor (1916-1919), Associate Professor (1919-1920), Professor and Chairman of the Department of Zoology (1910-1922). He resigned in 1922 to become Professor and Chairman of the newly founded University of Amoy, China, where he remained until 1924.

In 1920, he accompanied an expedition into the interior of Hainan Island and in 1924 he was a delegate to the Pan-Pacific Food Conservation Conference in Honolulu.

During these years in the Orient he published on zoological subjects including termites. He came to the University of California in 1924 to do graduate work for a Ph.D. and began, under Dr. C. A. Kofoid, to explore the flagellates of termites and to study the termite fauna of western United States. In the spring of 1925

he was appointed Associate in Zoology at the University of California and later in the same year a University Fellow; a Lecturer in Zoology in the fall of that year; a James M. Goewey Fellow in the spring of 1926; Asst. Professor of Zoology in 1926-27. He received his Ph.D. in 1926. His thesis was on termite flagellates. He was Associate Professor 1927-1929, and Professor of Zoology from 1929 until his untimely death by accidental drowning while swimming in Clear Lake, near Clear Lake Resort, Calif., June 21, 1947.

On January 1, 1925, he married Mary Nexbitt Holdcroft (A.B., Park College) at Redwood City, California. She is at present residing in Alameda, California.

Dr. Light was a remarkable teacher and leader of students as well as an unusually conscientious coöperator. He was always interested in entomology and for many years served as an Officer of Instruction and Advisor of the Division of Entomology and Parasitology. He also served on many of the committees in charge of the qualifying examinations and theses of graduate students in this Division. His thorough understanding and keen interest in research and in teaching problems made him a valuable addition to the entomological program in the College of Agriculture.

He was also interested in many outside activities and during his residence in Berkeley he became an important member, officer, and councillor in the First Congregational Church.

He began publication in 1913 and in all, prepared 70 papers.

In entomology his chief interest was termites, in which group he made notable contributions in the systematics and biology of these remarkable social insects. His discoveries on parthenogenesis and caste determination are especially important.

He was a member of the American Association for the Advancement of Science; Entomological Society of America; American Association of Economic Entomologists; Cooper Ornithological Club; Western Society of Naturalists; American Eugenics Society; American Society of Zoologists; American Society of Parasitologists; Society of Experimental Biology and Medicine; La Société Linnéenne de Lyon; China Society of Science and Arts; Royal Asiatic Society (North China Branch); Sigma Xi, Phi Sigma.

Dr. Light's collection of termites was disposed of as follows: a large portion was presented to Dr. A. E. Emerson, University of Chicago, in 1939; and approximately, 1,000 specimens, representing many species including paratypes, were presented to the

Department of Entomology, California Academy of Sciences, San Francisco, during the same year. He also determined and described species in the collections of the Academy.

The writer is indebted to Dr. Richard M. Eakin, Chairman of the Department of Zoology, University of California, and to Miss Frances Weesner, technician in the Department of Zoology for much of the information contained herein.

A complete bibliography of the published works of Dr. Light will appear in zoological and other scientific papers. His contributions to entomology are as follows:

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The life cycle of a higher termite, *Gnathamitermes perplexus*.
The Incipient Colony of *Tenuirostritermes tenuirostris*.
Culture groups of higher termites.
Further studies on *Zoötermopsis*. (Supp. reprod.; soldier prod.)
Further studies on *Reticulitermes*. (Life cycle; incipient colony; soldier production.)

BIOLOGY OF ARIZONA TERMITES WITH EMPHASIS ON SWARMING

BY S. F. LIGHT AND FRANCES M. WEESNER
University of California, Berkeley

The biology of most of the species of termites occurring in the United States is very imperfectly known. Records as to time and manner of swarming are few and incomplete or of local significance. Much of the information available is found in Snyder's account (1920 a) of the biology of the Neartic termites. For the few economically important western species relatively complete accounts are found in Kofoid, Light, et al (1934).

The present studies were made during the spring and summer of 1946 while conducting laboratory studies of the higher termites in Arizona (Light and Weesner, 1947 a, b). Headquarters was near the upper altitudinal limit of the range of these termites at the 5000 ft. level in Miller Canyon, on the eastern slope of the Huachuca Mountains, Cochise County. This is in the lowermost oak zone (encinal) where it meets an extension of the great plains grasslands in the San Pedro valley.

While at this location and during field trips to other localities observations were made on the biology of the following species, with emphasis on the three species of Termitidae:

Family Kalotermitidae

Zootermopsis laticeps (Banks) 1906.
Paraneotermes simplicicornis (Banks) 1920.
Kalotermes hubbardi Banks 1920.
Kalotermes minor Hagen 1858, Banks 1920.

Family Rhinotermitidae

Reticulitermes tibialis Banks 1920.
Heterotermes hoferi (Banks) 1920.

Family Termitidae

Gnathamitermes perplexus (Banks) 1920.
Amitermes wheeleri (Desneux) 1905.
Tenuirostritermes tenuirostris (Desneux) 1904.

Unless otherwise stated the records given below are for the zone from 4500 to 5000 feet near Miller Canyon, Huachuca Mountains, Cochise County, Arizona, summer of 1946. Reports of present status of cultured incipient colonies and groups are for March, 1947.

ZOOTERMOPSIS LATICEPS (Banks)

Termopsis laticeps Banks 1906, 1920.
Zootermopsis laticeps (Banks), Emerson 1933, Sumner 1933.

Winged adults are reported by Snyder (1920) to have been taken at Garcie and Palmerlee, Arizona, in June and July, and in the Santa Rita and Santa Catalina Mts., Arizona, in July. Snyder says "this termite swarms in June or July."

No colony of this rare species was encountered by us but alates were taken by the junior author at the lantern and at lighted windows on two successive nights. They appeared singly and at intervals from 1 A.M. to 4 A.M. on July 4, a warm night but without rain. Six alates were taken at intervals at the lantern the next night from 11 P.M. to 12:45 A.M., again a warm night with no rain. These alates are slow, strong fliers.

Attempts to rear incipient colonies of *Z. laticeps* were unsuccessful although its two coastal congeners lend themselves readily to culture.

PARANEOTERMES SIMPLICICORNIS (Banks), Light 1934

Kalotermes simplicicornis Banks, 1920, p. 32, Snyder 1926, Light 1926 a, 1927.
Cryptotermes infumatus Banks, 1930, p. 38.
Neotermes simplicicornis Banks, Light 1929 a, b,; 1930.
Kalotermes (*Neotermes*) *simplicicornis* Banks, Cupp 1930, Light 1931.
Kalotermes (?) *simplicicornis* Banks, Light 1933.
Paraneotermes simplicicornis Banks, Light 1934 a.
Kalotermes (*Paraneotermes*) *simplicicornis* Banks, Light 1937.

There are no published records of natural swarming. Light (1937) reports finding alates in colonies in the Coachella Valley, San Bernardino County, California, in October and November and describes their flight from the opened workings. There had been no rain in that locality for more than a year which probably accounted for their presence in the colony so late. Both their coloration and behavior indicate that they are day fliers.

A large colony, taken by us at Fairbanks, Cochise County, Arizona, on May 2, contained many brachypterous nymphs but no alates. An alate appeared early in June in cultures set from this group. On June 27 alates were found to be numerous in two of the groups and presumably they were present in field colonies at least by that time.

A large colony which was opened by the junior author at 9:30 A.M., July 19, at Coldwater near Phoenix, emitted a swarm of alates which flew off rapidly. There had been a heavy rain the night before and it seems probable these would have swarmed later that day.

Primary pairs did not flourish in culture. Several have persisted for more than eight months, and eggs have been recorded from time to time. Two of them contain eggs at present and one contains a medium sized nymph. Young were recorded in three other colonies about 100 days after setting. No pair developed a normal incipient colony.

Groups of nymphs of this species did not prove to be good subjects for laboratory culture. Most groups were closed out at the end of ten weeks at which time the population surviving was low, ranging from 30% to 55%. One to three supplementaries per group were recorded five weeks after setting and eggs were seen in some groups two weeks later. No young were reported in groups of this series in which the groups consisted of 17 nymphs each. One larger group of 60 nymphs and 10 soldiers, set May 2, is flourishing. It was set in a three-ounce jar with wood blocks covered with loose moistened soil of origin. Supplementaries were first seen in this group June 27 and eggs on July 18. At present visibility is not good but numerous young nymphs of several instars are to be seen and probably there are eggs.

KALOTERMES HUBBARDI Banks 1920

Snyder (1920) records alates taken flying in Sabino Canyon, Pima County, Arizona, from June 20 to July 28, 1918, and again June 30 to August 28, 1919, at lights. He also reports them at Tucson and Redington, Arizona, in July. Presumably this very light-colored species is always typically a night flyer.

They emerged in numbers, during the late evening of July 14 from heavily infested dead cottonwood stubs collected at St. David,

Cochise County, Arizona, on April 30 and kept on the porch of the laboratory.

The junior author observed alates in colonies in giant cactus near Phoenix on July 19. There had been a heavy rain the night before and they were found in flight at 8:30 P.M. that night near Mesa. The swarming alates were very numerous, collecting about lights.

Incipient colonies were cultured with indifferent success. Of six persisting, four contain nymphs but only about two per colony.

Groups of nymphs of this species were cultivated with marked success and are doing very well both in the original cultures and after transfer to new culture jars. Our results indicate that it is much the most favorable species of *Kalotermes* for laboratory experiments.

Supplementaries were produced in laboratory groups, the first after 23 days. However, with one doubtful exception no eggs have been recorded.

KALOTERMES MINOR Hagen 1858, Banks 1920

Calotermes marginipennis Latreille, Hagen 1858, p. 47, "Variet. Minor," ("Californien").

Calotermes marginipennis Latr. Hagen, 1860 p. 100, "*Var. Minor*" in text; ("Aus Califonien" . . . von *San Diego*").

Calotermes marginipennis ! Hagen 1861, p. 2, "Var." ("San Francisco and San Diego, California".

? *Calotermes castaneus* Bermeister, Hagen 1858, p. 38 ("Kalifornien (San Francisco)").

? *Calotermes castaneus* !, Hagen 1861, p. ("San Francisco, California (Chamisso)").

Kalotermes minor Hagen, Banks 1920, Snyder 1926, Light 1926 b, 1929 a, 1930 a, 1933, 1934 a, Hendee 1933.

Snyder reports flights in July in Arizona and that the alates were taken at lights frequently with *K. hubbardi*, in Sabino Canyon, Arizona. Harvey's extensive records (Kofoid, Light et al, 1934) show the species to be a day flyer in southern California as its dark color would indicate it to be normally. Brilliant sunshine and temperatures from 80° to 100° F. were found by Harvey to be conditions requisite for flight. Swarms were recorded for southern California from late September to early November, chiefly in the middle of the day from 11:30 A.M. to 3 P.M. A careful study might

show the night fliers in Arizona to be late stragglers from heavier daylight swarming.

We found this termite to be common in the walnuts and sycamores of the canyons and washes of southeastern Arizona. Alates were found in colonies in sycamores on July 5 but we observed no flights.

Primary pairs taken from colonies responded poorly to culture. No pair developed a normal incipient colony. All but one of the persisting pairs produced eggs at some time but only a few young were known to have been produced and only in two groups.

RETICULITERMES TIBIALIS Banks, 1920

Reticulitermes humilis Banks 1920 (ex parte).

R. humilis Banks, Light 1933, 1934 b, Snyder 1926, 1934 (in Kofoid, Light et al).

R. humilis Banks, Light 1933.

Nec *R. humilis* Banks var. Hoferi Banks 1920 (see *Heterotermes hoferi* (Banks)).

Nec *R. humilis* Banks 1920 from Tucson and fig. 38, (see *Heterotermes hoferi*).

R. tibialis Banks 1920, Snyder 1920 a, Light 1929 a, 1930 a, 1931, 1933, Pickens 1934 (in Kofoid, Light et al), Snyder 1934 (in Kofoid, Light et al).

Emerson (personal communication) considers *R. humilis* Banks to be a synonym of *R. tibialis* Banks whose very great range, California to Illinois, makes it seem probable that it will prove to be a Rassenkreis of which *R. humilis* may represent one subspecies.

This termite, abundant in fence posts, oak stubs, etc., in southeastern Arizona was little studied by us. No flights were observed by us nor were alates found in the colonies opened. Our attention was largely directed toward the higher termites and we might well have missed a flight. The only colony at all fully collected was taken early in March. It contained many large brachypterous nymphs at about the stage of those found in colonies of Termitidae at the same date and which in these colonies developed into alates in late May. In California alates of *R. tibialis* emerge with the rains as do those of *R. hesperus*. There the rains come in the fall. Spring, summer and fall flights of *R. tibialis* have been reported by Snyder (1920), that for Arizona in July, and Snyder (1920) reports that *R. humilis* (=*R. tibialis* of Arizona), "swarms during the last of June or July," his reports being from Arizona.

A large series of groups from one colony proved this species to be an even better laboratory animal than its congener *R. hesperus*. Of the 56 groups set only two died out after 5 months. From 1 to 3 brachypterous supplementaries were produced after 35 days in each of 18 groups each of which contained 4 brachypterous nymphs. A single supplementary was present in one group of apterous individuals after 63 days. At the end of 5 months they were present in only half of the apterous groups. The supplementaries which were produced in them were apterous, presumably from late pre-worker apterous nymphs. The possibility remains that workers of this species may become supplementaries; workers and late apterous nymphs are hardly distinguishable. Pickens (1932) found the same delayed production of apterous supplementaries in groups of apterous individuals.

Eggs and young were produced much earlier and in greater numbers in the groups containing brachypterous supplementaries than in those groups composed entirely of apterous individuals.

HETEROTERMES HOFERI (Banks) 1920, Snyder 1926

Reticulitermes humilis Banks var. *Hoferi* Banks 1920, Snyder 1920.
Reticulitermes hoferi Snyder 1926 p. 392.
R. humilis Banks 1920 (ex parte, Tucson and Lower records; fig. 38, 1).
R. aureus Snyder 1920 b.
Leucotermes aureus Snyder 1926, Light 1929 b.
Heterotermes aureus Snyder, Light 1930 a, 1933, 1934, Pickens and Light 1934 (in Kofoid, Light et al).

There seems no doubt that the soldiers allocated by Banks (1920, p. 53) to "*Reticulitermes humilis* Banks var. *Hoferi* new variety" are the soldiers of the only species of *Heterotermes* occurring in the United States. The specific name *hoferi* Banks, February 15, 1920, has precedence over Snyder's name *Reticulitermes aureus* February 18, 1920, given to the alates of the same species as Snyder himself points out (1926, p. 392).

This species, not present near headquarters, was collected by the junior author at Apache Junction and near Mesa, Maricopa County, Arizona, on July 19 and 20. No alates were present in the 10 colonies observed at Apache Junction, including a very large colony collected for use in setting up laboratory groups. This large colony

did not include brachypterous nymphs nor were they recorded for the other colonies. It seems probable, therefore, that the flight had already occurred in this locality. Alates were seen, however, in two colonies out of 8 south of Mesa on July 20, which was the day after the first heavy rain of the season.

Light (1932) reported alates of *Heterotermes aureus* taken with *Amitermes perplexus* ("*Amitermes magnoculus*" Light) at Calexico, California, between 7 and 8 P.M. September 11, 1930, a very dry year, following a hard rain from 4:15 to 5 P.M. Again in 1931 the two were taken together at the same place in the evening of August 4 following a gentle rain.

Numerous eggs were produced in each of three incipient colonies set and young developed. The persisting colony was transferred to a new culture vial on the 9th of January. It contains three young in a late instar and one egg.

The large colony collected in a smokewood tree near Apache Junction was used to set 100 groups of apterous individuals supposedly largely workers. Various culture methods were used. Smokewood chips or sawdust was used for food in sixty of the hundred since it was the wood of origin. This proved unfortunate since in all of these cultures a scum appeared on the agar surface accompanied by a foul odor; the termites died rapidly and a heavy fungus growth occurred. The forty groups cultured in the standard sawdust (Light and Weesner, 1947 a) flourished. Of these ten have been kept, a few in the same cultures, others transferred to new cultures, and are doing well.

At no time have supplementary reproductives, eggs or brachypterous nymphs been seen in any of these groups although they were set up eight months ago.

GNATHAMITERMES PERPLEXUS (Banks)

Termes tubiformans Buckley, Desneux 1905; nec *Termes tubiformans* Buckley 1863.

Amitermes perplexus Banks 1920.

A. confusus Banks 1920, Light 1934 a.

A. arizonensis Banks, Light 1930 a, 1931.

Amitermes (*Gnathamitermes*) *perplexus* Banks, Light 1932, 1834 a, b.

A. (*G.*) *acutus* Light 1932, 1934 a.

A. (*G.*) *acrognathus* Light 1932, 1934 a.

A. (*G.*) *fuscus* Light 1932, 1934 a.
A. (*G.*) *infumatus* Light 1932, 1933, 1934 a.
A. (*G.*) *confusus* Banks, Light 1932, 1934 a.
A. (*G.*) *magnoculus* Light 1932, 1934 a.

Light (1932) described several of the varieties of this wide ranging species as separate but closely related species. However, continued study of growing collections made it increasingly probable that these are varieties rather than species. The senior author now agrees with Emerson (in litt.) that but two species of *Gnathamitermes* are known from the United States, *Gnathamitermes tubiformans* (Buckley) and *G. perplexus* (Banks).

A. arizonensis Banks 1920 included soldiers of this species but was based on alates of *A. wheeleri* (Desneux) as shown by Light (1932), leaving *A. perplexus* Banks 1920 as the name for the common desert termite of southern California, Arizona, New Mexico, Texas and northern Mexico (Light 1933). Two additional species, *G. grandis* Light (1930 b) and *G. nigriceps* (Light 1930 b) occur in Mexico and have not been reported from the United States.

Large brachypterous nymphs later to molt into the summer's alates were present from our arrival in early March. Eggs were first recorded on April 25, callows (from the apterous nymphs of the previous year) on April 5, soldier nymphs and callow soldiers (from the previous year's brood) on May 15, young on May 1 (first instars only), young brachypterous nymphs on June 20.

Numerous alates were present in at least one colony on June 1 and they were found in colonies until the middle of July. On June 6 they were seen in 8 out of 10 colonies opened and were probably present in most of the colonies at that date.

Numerous records (Snyder 1920, Light 1932, pp. 397, 407) show *G. perplexus* to have been taken in flight in late June or July, usually in the evening after rain. However, one record had them flying at 9:15 in the morning, another from 2 to 4 P.M. during a steady rain.

Five flights were recorded in the vicinity of headquarters and another at Phoenix as follows:

(1) June 16, a few taken on windshields and others seen in flight in light of headlights after dark, about 8 P.M. during a light shower after a fairly heavy short afternoon rain.

(2) July 2, emerging from crack in concrete bottom of old swimming pool at 3:30 P.M. during light rain (mostly killed and carried off by ants).

(3) One seen in flight somewhat later that afternoon on Highway 92 during a light rain.

(4) July 6, seen emerging from two holes in front of laboratory between 5:15 and 5:40 P.M. Workers and soldiers active at the emergence holes. Ground wet from shower at 4:45 P.M., probably very light rain at time of emergence. From numbers seen in flight there were evidently several other colonies swarming nearby, all within the live oak zone. Weak-looking, but actually effective flyers. Flying with wind toward the southeast. Some seen to alight and take off again. No dealation or pairing seen. Numbers small, emergences at intervals, flight long and desultory. Seems very improbable that pairing eventuated.

(5) July 12, heavy flight at 2:30 P.M. during slight showers following heavy rain at 2 P.M. Many were seen in flight as we drove down to Highway 92. Some were still flying along highway but most were already dealated on the ground. Numerous pairs seen, also singles. Some pairs were taken immediately under rock surfaces, some in shallow depressions under rocks where they had started to work in earth, and some in tunnels under rocks where they had burrowed an inch or more into soil. In numerous instances more than one pair were under the same rock and in several instances two pairs were burrowing in a common passage. This was probably the main flight in that area. No other flights were recorded there.

(6) July 19, Phoenix, about 100 seen in flight when sun broke through overhanging clouds at 6:30 A.M. Ground soaked and water standing in pools from an extremely heavy night rain, the first rain of the season in that vicinity.

The colonies of *Gnathamitermes* were to be found in earth under stones as was true of *Amitermes* and *Tenuirostritermes*. They evidently foraged widely through the soil, however, since they were found in a high percentage of the cowchips as was *Amitermes* but not *Tenuirostritermes*.

Many experiments were set up from *Gnathamitermes* colonies with a view to finding a satisfactory method of culturing groups

of the workers and apterous nymphs plus, in some instances, brachypterous nymphs. In general these attempts were not especially successful although many groups persisted up to more than two months and in the first such series more than three months. These experiments will be more fully reported elsewhere.

Brachypterous nymphs became pigmented supplementary reproductives in a number of laboratory groups. Both supplementaries and brachypterous nymphs were much more hardy than the workers and apterous nymphs and persisted long after the entire apterous population was dead.

In only one instance were eggs seen in these groups headed by experimentally produced supplementaries.

More than 400 incipient primary colonies were set up and some seemed to proceed normally. No soldiers nor workers developed, all individuals remaining in the late apterous nymphal stage. Detailed results will appear elsewhere.

Amitermes wheeleri (Desneux), Light 1932

Termes wheeleri Desneux 1905.
Amitermes arizonensis Banks 1920 (alates ex parte?).
A. californicus Banks 1920 (soldiers), Snyder 1926, Light 1930 a, b, c, 1931.
?*A. parvipunctus* Light 1932.
?*A. spadix* Light 1932.
A. (*A.*) *wheeleri* (Desneux) Light 1932 a, b.
Nec *Amitermes wheeleri* Desneux, Banks 1920 "Brownsville and San Antonio" (=*A. minimus* Light 1932).
Nec *A. wheeleri* Desneux, Snyder 1926, (=*A. minimus*).
Nec *A. wheeleri* Desneux, Light 1930 a, b, c, 1931 (=*A. minimus*).

This widespread and variable species is found living under a wide range of climatic conditions. Records of its biology are few and unreliable because of its checkered systematic history. Alates were taken by us in colonies on several occasions in flights. The alates taken on all occasions agreed as to color, size and general appearance. There is no question that these are the alates of *A. wheeleri* of this region. They differ in the generally darker color from the previously described alates of *A. wheeleri* (Light 1932). In life they gave the impression of being smoky black with gray-black wings. Fixed specimens show a brown color not noticeable in life. These were taken from a colony of June 1 the day when

alates were first recorded. It seems probable that they had not acquired full pigmentation. The head is a dark smoky brown, the pronotum slightly lighter, legs and outer antennae are smoky, postclypeus pale smoky, anteclypeus and labium pale yellow.

Most of the alates taken were used to set up incipient colonies. Only six alates from one colony were saved for study. Measurements of these show them to agree very well with the alates of *A. wheeleri* from Texas described by Light in 1932 and with *A. parvipunctus* Light (1932) and *A. spadix* Light (1932). They show considerable variation as to size and shape of the fontanel. It seems probable as indicated in the synonymy that *A. parvipunctus* and *A. spadix* are synonyms of *A. wheeleri.* The variation in markings of the head and pronotum and in the size and shape of the fontanel may not be significant and can only be evaluated by studies of large series. They may prove to be of subspecific value if, as seems probable, this wide-ranging species proves to consist of several subspecies. It ranges from the California desert eastward to Brownsville, Texas, and from Las Vegas, Nevada, southward at least as far as the city of Colima, Colima, Mexico (*A. californicus*, Light 1930).

A. pallidus differs in coloration and size from all the alates here assigned to *A. wheeleri* and must be considered to represent a different species.

Since *A. wheeleri* was smaller and less abundant than *G. perplexus*, the latter was studied more carefully and used more extensively in culture and experiments hence the records for *Amitermes wheeleri* are casual.. Actually *A. wheeleri* proved much the better laboratory animal so far as group cultures were concerned whereas the incipient colonies of *G. perplexus* were much more successful in the laboratory than those of *A. wheeleri.*

The constitution of the colonies in March was the same as for *G. perplexus.* The large brachypterous nymphs which were to molt into alates in May or early June, were present presumably from the first but were first recorded on March 15. No supplementaries were found in colonies but brachypterous nymphs in experimental groups developed into dark brown supplementaries as they did in the two other species of Termitidae. The first was recorded 46 days after segregation of the group. Worker-like apterous nymphs were present in considerable numbers from our arrival in March, as in *G.*

perplexus, and could be distinguished from the workers but with more difficulty than in *Gnathamitermes*.

On June 1 alates of all three species were brought in from colonies. This was the first record of alates in a colony of *A. wheeleri*. Only a few were present in one colony and brachypterous nymphs were abundant whereas in *G. perplexus* at that time there were few brachypterous nymphs and alates predominated and in *Tenuirostritermes* there were many alates and no brachypterous nymphs.

Three flights were observed by the senior author all in mid July and all under similar conditions. They all occurred in late afternoon, from 5:30 to 7:15 P.M., when the sun broke through the clouds on days when earlier rains had wet the ground. The flight was general over the areas observed but was brief and terminated sharply when the sun went under a cloud or fell behind the mountains. The alates flew with the wind. They appeared feeble but were actually strong fliers. It was difficult to keep up with them by running. Some traveled at least several hundred yards. Several were seen to light and take off again. No dealated individuals or pairs were seen and it was difficult to conceive of many pairs together unless the flights are heavier as they may well have been at some swarming missed by us.

The first recorded flight was at 7:07 P.M. on July 12, when there was a heavy rain storm at 2:30 P.M. during which *G. perplexus* made its first recorded flight. The flight was general but was seen for only about 20 minutes, during which alates in flight while scattered were in sight in every direction. Some issued from holes very near those from which had issued the alates of the July 6 flight of *G. perplexus*.

On July 14 alates were first seen at 6:45 P.M. with a brisk wind blowing. The maximum flight began when the wind fell about 7:07. At one spot, supposedly a single colony, 16 holes of issue were counted and it was estimated that there were about 30 such holes. Each aperture was minute. As a rule only one alate issued at a time. The large number of holes may provide some safety from ants which were attacking them very actively.

The last flight on July 18, was observed to last only about 10 minutes, beginning everywhere within the range of vision a few minutes after the sun emerged and terminating at once when the sun fell behind the mountains. It had rained heavily the day before,

and there had been a slow shower earlier that afternoon. The temperature was low.

Amitermes wheeleri would seem on the basis of this slight evidence to differ from *G. perplexus* in swarming habits in that *A. wheeleri* is not dependent upon rain at the moment of flight but 1) is a diurnal flyer as its dark color would indicate but flies in the late afternoon or early evening, 2) is dependent upon moisture from recent rains, 3) flies during a brief period on any given day (because near the time of the setting of the sun), 4) is able to fly on relatively cold days but 5) is dependent upon the brief warming action of the sun.

Tenuirostritermes tenuirostris (Desneux)

Termes tenuirostris Desneux 1904.
Constrictotermes tenuirostris Desneux, Banks 1920.
Nasutitermes (*Tenuirostritermes*) *tenuirostris* Desneux, Light 1934 in Kofoid, Light et al.
Nasutitermes (*Tenuirostritermes*) *cinereus* (Buckley) Light 1934 b.

Emerson, who will shortly publish a revision of *Tenuirostritermes*, has identified the Arizona species as the type species of the genus (personal communication). The biology of this species will be more fully reported later by the junior author.

Snyder (1920) reports that this species swarms at night. Most of his records are from the mountains of Arizona and all are for July except for one on June 25, 1899, in the Huachuca Mountains. Nothing is said as to temperature or relations to rainfall which according to the observations of the junior author are of limiting importance. Her observations are summarized below.

Alates were first seen in a colony on May 27. They were present in small numbers as late as August 7 in 3 out of 7 colonies in the lower pastures where rainfall was lighter.

Although only two swarmings are known to have taken place the conditions necessary for flight seem clear from the conditions known to have occurred during those two flights and those obtaining on the very many occasions when rains furnished the requisite moisture but no flight occurred. The essential conditions seem to be 1) maturity of the alates, presumably attained by the latter part of June, 2) a warm night rain, presumably a long soaking rain or a lighter rain following a previous wetting.

Observations in the field at all times of the day but especially at night on occasions from July 3 to August 1, during rains, after

rains, and when no rains had occurred, using the gasoline lantern at nights, were entirely without results except on the nights of July 10 and 21. These were nights of warm rains, 72° F. on July 10, whereas the other night rains were cold.

On July 10 the flight was heavy and presumably general. Alates were first seen flying to lighted windows situated 300 yards above the nearest colonies. They were seen to dealate and pair. Flight was observed to last from 10 P.M. to 10:45 P.M., during fairly heavy rain which began at 9:30. No flight was observed at the lantern during a similar rain the preceding night but this was the first rain for some time and the ground was dry.

After the rain stopped at 11 P.M. many wings were found on the ground where the colonies were located but no further flight was observed. The number of alates in colonies was considerably reduced after this date especially in the higher levels where rain fall was the greatest.

On July 21 it rained from 9 to 10 P.M. but no flight occurred. It rained again about 2 A.M. and then the flight presumably occurred since numerous wings were found in the lower pasture the next morning.

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NEW GENERA AND SPECIES OF PAUROPODA FROM CALIFORNIA

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The six new species of pauropods described herein are placed in two families, Brachypauropodidae and Eurypauropodidae, which have not previously been recorded from western North America. Each family is represented by a single species in the eastern United States.

On the basis of differences in rate of locomotion, Latzel (1883, 1884) divided the pauropods into "Pauropoda agilia" and "Pauropoda tardigrada," the former including the family Pauropodidae and the latter the families Brachypauropodidae and Eurypauropodidae. This distinction has not been retained as the primary division in modern classifications (e. g. Bagnall, 1935), but provides a convenient field character to distinguish the active, centipede-like Pauropodidae from the very slow-moving Brachypauropodidae. The pillbug-like Eurypauropodidae are moderately slow-moving forms. The Pauropodidae is the dominant family of the class from the standpoint of number of species, since it contains 90 percent (115 species and subspecies) of the described species. Of the 28 species of pauropods previously known from North America, 26 belonged to this family. The Brachypauropodidae contains five species, the Eurypauropodidae 12 species in the world fauna. The three remaining families, none of which has been recorded from North America, contain a total of nine species.

The definition of the class Pauropoda must be extended to include forms with only eight pairs of legs in the adult stage, since the three new genera described here are all believed to possess this characteristic. Pauropods have previously been characterized as possessing nine, or rarely ten pairs of legs.

Specimens were collected in the field by searching twigs or fallen logs, especially where leaf mold had accumulated, with the aid of a hand lens. It was found that Berlese-funnel extraction of litter gathered indiscriminately did not give good results in collecting the "Pauropoda tardigrada." Exceptionally favorable bits

of wood, which often harbored colonies of scores of individuals, were brought into the laboratory for further examination under a binocular microscope, since adults of some species are quite small, not exceeding 0.6 mm. in length. A thousand or more individuals of the families Brachypauropodidae and Eurypauropodidae were collected in four days of field work by these methods. Three localities in the San Francisco Bay area furnished most of the specimens: a small canyon in the Black Hills (about 1000 feet elevation), on the south slopes of Mt. Diablo, Contra Costa County, about two miles above the south entrance checking station of the Mt. Diablo State Park; Woolsey Canyon, a short distance north of the campus of the University of California, Berkeley; and numerous small canyons between Fairfax and Alpine Lake (three miles west of Fairfax) in Marin County. A single specimen of *Gravieripus* was collected from under redwoods in the Redwood Regional Park, near Oakland.

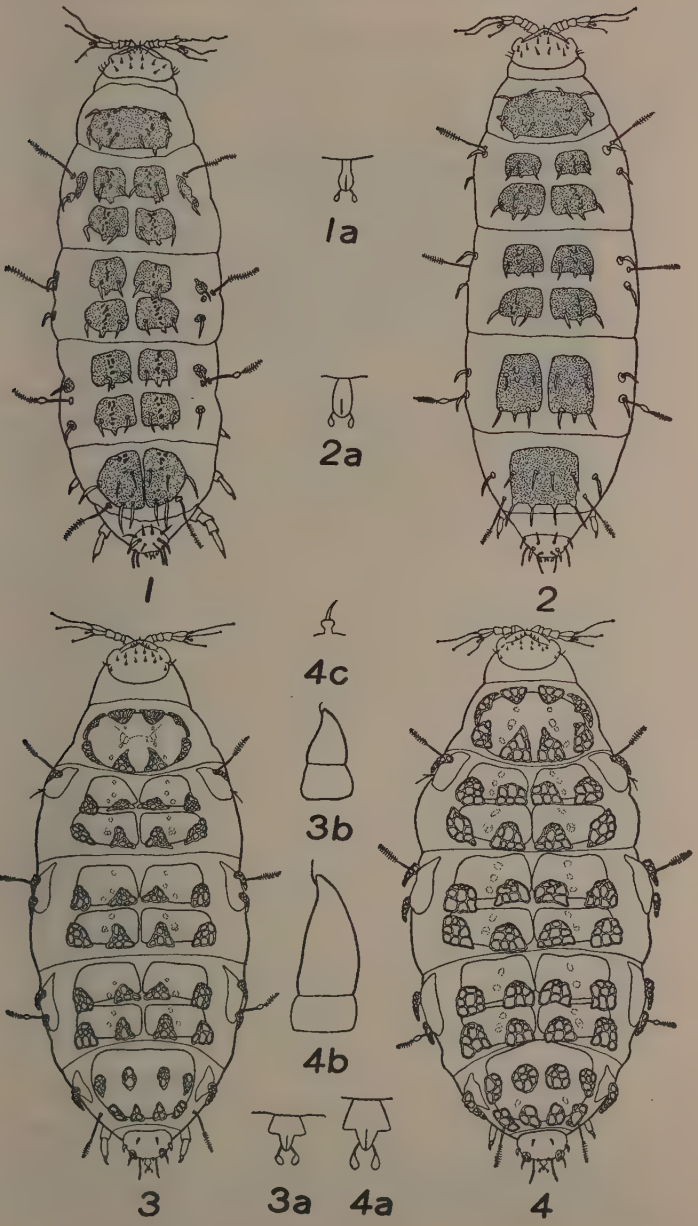
A good introduction to the literature may be found in the work of Starling (1943), in which is presented a bibliographic list of the species of Pauropoda of the world. More recent publications of general interest are furnished by Starling (1944) and by Tiegs (1947).

All material studied was cleared in KOH, stained lightly with acid fuchsin in acetic acid, washed in absolute alcohol, then transferred to clove oil and mounted on microscope slides in balsam.

The following descriptions are based mainly on the holotypes, but the nature of the material has made it necessary to describe certain details from other male specimens in the type series. All measurements are made from specimens mounted on slides, which are somewhat expanded.

Paratypes of all the species have been deposited in the collections of the United States National Museum and the British Museum (Natural History).

Plate I: Fig. 1, *Zygopauropus hesperius*, dorsal view, holotype male x 140; 1*a*, ventral view, anal plate x 620; Fig. 2, *Aletopauropus lentus*, dorsal view, holotype male x 140; 2*a*, ventral view, anal plate x 620; Fig. 3, *Deltopauropus luteus*, dorsal view, holotype male x 140; 3*a*, ventral view, anal plate x 620; 3*b*, lateral view, male organ x 550; Fig. 4, *Deltopauropus magnus*, dorsal view, holotype male x 105; 4*a*, ventral view, anal plate x 620; 4 *b*, lateral view, male organ x 550; 4*c*, dorsal head seta x 620.


1a
2a
1
2
4c
3b
4b
3
3a
4a
4

Family Brachypauropodidae Kenyon

As originally defined, this family was characterized by having the head, legs, and pygidium free, and the tergal plates of all segments subdivided. The family was assumed to have the usual 9 pairs of legs. The definition is extended here to include forms which have the tergal plates of segment 5 entire, and forms with only 8 pairs of legs in the adult stage.

Zygopauropus MacSwain and Lanham, new genus

Body form narrowly ovate; fresh specimens with loose, mealy, white substance on setae of dorsum and on trichobothria; slow-moving forms.

Head. Ocular areas appearing as lateral lobes; a single seta present between antennal insertions; anterior two-thirds of head covered with sclerotized plate bearing anterior group of 6 and posterior group of 10 setae; 3 slender lateral bristles behind each ocular area; row of 8 slender hairs on anterior margin of ventral surface of head.

Antennae. Scape with segment 2 conspicuously shorter than rest of segments; stylus latior slightly shorter than stylus angustior, both subequal in width.

Trunk. Five segments present; terga with entire or subdivided sclerotized plates. Segment 1 with a single tergal plate bearing 4 pairs of setae; segments 2, 3 and 4 each with tergal plates divided longitudinally and transversely into 4 parts, each part bearing a pair of setae; segment 5 with tergal plate divided longitudinally into two parts, each part bearing 5 setae. Segments 2, 3 and 4 with a pair of lateral setae on each side, corresponding setae on segment 5 represented by a single seta inserted on lateral margin of tergal plates. Setae bristle-like or slightly hastiform, strongly bent posteriorly near base. Four pairs of trichobothria present; those of segment 4 (third pair) strongly clavate, with club bearing apically a loosely plumose filament which is subequal to stalk of trichobothrium in length; those of segments 2, 3 and 5 filamentous, loosely plumose apically.

Legs. Eight pairs of legs present, all 5-segmented; coxa and trochanter each with a single annulated seta, tarsus with 3 setae; claw slender, pulvillus with a single bristle.

Type: *Zygopauropus hesperius* MacSwain and Lanham.

Zygopauropus hesperius MacSwain and Lanham, new species

Male. Color white; length 0.54 mm., width 0.17 mm.

Antennae. Stalk of globulus approximately one-third length of stylus latior, widened apically, posterior flagellum about two-thirds

length of anterior flagellum; stylus angustior widest near middle, its flagellum about one-fourth longer than anterior flagellum of stylus latior.

Trunk. Tergal plate of segment 1 with 2 longitudinal rows of irregular tuberosities, the last of each row appearing as large scales projecting beyond posterior margin of plate, tips of scales more or less jagged; tergal plates of segments 2-4 each with a similar row of tuberosities and posteriorly projecting scales; plates of segment 5 with tuberosities not so well developed and not extending beyond posterior margin. Tergal plates with ground sculpture of small, closely spaced, rounded tubercules. Lateral platelets usually subdivided into small sclerotized areas surrounding insertions of lateral setae, but occasionally platelets are entire. Trichobothrium of segment 2 inserted slightly before anterior lateral seta, trichobothria of segments 2 and 3 inserted lateral to and somewhat posterior to anterior lateral setae, trichobothrium of segment 5 inserted a considerable distance behind lateral seta. Penes constricted near middle, base broadened, apical portion subovoid, with subapical bristle.

Pygidium. Anal plate with basal portion expanded, stoutly clavate in outline, distal portions consisting of short, very strongly capitate hairs; sternum with posterior setae (b^1) moderately tapering, about 4 times as long as styli, anterior setae (b^3) slender, approximately equal in length to styli; styli rod-shaped, subequal to anal plate in length, tips rounded; tergum with row of 4 anterior, moderately strong setae (d, d^1 of Remy, 1936), lateral setae (a^3) half again as long as the thick, slightly sinuous intermediate setae (a^2), submedian setae (a^1) very slender, slightly longer than styli.

Female: Similar to male. Length 0.56 mm., width 0.20 mm.

Holotype, adult male (No. 5897, Calif. Acad. Sci., Ent.): South slopes of Mt. Diablo, Contra Costa County, California, 12 November 1947, under fallen oak branches (MacSwain and Lanham). *Allotype*, adult female (No. 5898, Calif. Acad. Sci., Ent.): same data as holotype. *Paratypes:* 1 adult male, 3 adult females, same data as holotype; 2 adult males, Fairfax, Marin County, California, 24 November 1947 (MacSwain and Lanham). Additional material includes 4 immature specimens with same data as holotype; one has 6 pairs of legs, two have 5, one has 3 pairs of legs.

Aletopauropus MacSwain and Lanham, new genus

Body form narrowly ovate; fresh specimens with loose, mealy, white substance on setae of dorsum and on trichobothria; slow-moving forms.

Head. Ocular areas appearing as distinct lateral lobes; single seta present between antennal insertions; anterior two-thirds of head covered with sclerotized plate bearing anterior group of 6 and posterior group of 10 setae; 1 pair of slender lateral bristles behind each ocular area; row of 8 slender hairs on anterior margin of ventral surface of head.

Antennae. Scape with segment 2 conspicuously shorter than rest; stylus latior subequal in length and width to stylus angustior.

Trunk. Five segments present; terga with entire or subdivided sclerotized plates. Segment 1 with tergal plate entire, with 4 pairs of setae; segments 2 and 3 with tergal plates divided into 4 parts, each part with 1 pair of setae; segment 4 with tergal plate divided longitudinally into two parts, each part with two pairs of setae; segment 5 with tergal plate entire, with 4 pairs of setae, the posterior row of setae inserted on posterior margin of plate. Segments 2-4 with 1 pair of lateral setae on each side; segment 5 with 1 lateral seta, which is distant from tergal plate. Setae bristle-shaped or slightly hastiform, abruptly bent posteriorly near base. Four pairs of trichobothria present; those of segment 4 (third pair) strongly clavate, with club bearing apically a plumose filament which is subequal to stalk of trichobothrium in length; those of segments 2, 3, and 5 filamentous, loosely plumose apically, subequal in length.

Legs. Eight pairs of legs present, all 5-segmented; coxa and trochanter each with a single annulated seta, tarsus with 3 setae; claw slender, pulvillus with a single bristle.

Type: *Aletopauropus lentus* MacSwain and Lanham.

Aletopauropus lentus MacSwain and Lanham, new species

Male: Color white; length 0.56 mm., width 0.18 mm.

Antennae. Stylus latior approximately half again as wide at tip as at base, tip asymmetrically rounded, posterior flagellum somewhat more than half as long as anterior flagellum, stalk of globulus approximately one-half length of stylus, widened apically; stylus angustior widest at distal one-third, its flagellum one-third again as long as anterior flagellum of stylus latior.

Trunk. Segment 1 with tergal plate sub-oval in outline, produced laterally into a small lobe. Tergal plates of segments 2 and 3 each with a median row of tuberosities, the last of each row forming a conspicuous, usually entire tooth on the posterior margin of each plate; tergal plate of segment 1 with 2 such rows and 2 teeth on posterior margin; plate of segment 5 with tuberosities very weakly developed, no teeth on posterior margin. Ground sculpture of tergal plates consisting of small, closely spaced, rounded tubercles. Trichobothrium of segment 2 arising alongside anterior lateral seta, of segment 3 between lateral setae, of segment 4 alongside posterior lateral seta. Penes constricted near middle, base broadened, apical portion subovoid in outline, with subapical bristle.

Pygidium. Anal plate with basal portion expanded, ovate in outline, distal portions consisting of short, very strongly capitate hairs; sternum with posterior setae (b^1) slender, approximately 4 times as long as styli, anterior setae (b^3) very slender, short, and inconspicuous; styli rod-shaped, subequal to anal plate in length, tips rounded; tergum with row of 4 slender anterior bristles (d, d^1 of Remy, 1936), lateral setae (a^3) slender, half again as long as the stout, slightly hastiform intermediate setae (a^2), submedian setae (a^1) slender.

Female: Similar to male; length 0.60 mm., width 0.20 mm.

Holotype, adult male (No. 5899, Calif. Acad. Sci., Ent.): Woolsey Canyon, Berkeley, Alameda County, California, 21 November 1947 (MacSwain). *Allotype,* adult female (No. 5900, Calif. Acad. Sci., Ent.): same data as holotype. *Paratypes:* 3 adult females, same locality as holotype, 26 November 1947 (MacSwain); 1 adult male, 3 adult females, same data as holotype. Other material includes 3 immature specimens; two have 6 pairs of legs, one has 5 pairs; all with same data as holotype.

Deltopauropus MacSwain and Lanham, new genus

Body form oblong-ovate; fresh specimens without white, mealy, substance on dorsum of trunk, but adult females with a conspicuous transverse white band of compact mealy substance on posterior margin of head; slow-moving species.

Head. Ocular areas appearing as distinct lateral lobes; a single seta present between antennal insertions; anterior two-thirds of head covered with sclerotized plate bearing anterior group of 6 and posterior group of 10 setae, anterior setae mounted on large tubercles; 2 slender lateral bristles behind each ocular area; row of 8 slender hairs on lower anterior margin of head.

Antennae. Scape with segment 2 conspicuously shorter than rest; stylus latior distinctly shorter than stylus angustior.

Trunk. Five segments; terga with entire or subdivided sclerotized plates. Segment 1 with tergal plate entire, bearing 4 pairs of setae; segments 2-4 with plates narrowly divided longitudinally and transversely into 4 parts, each part bearing one pair of setae; segment 5 with plate entire, bearing 4 pairs of setae. Setae highly modified, consisting of flattened triangular, subtriangular, or almost circular scales having surface ornamented with conspicuous network of raised lines; anterior row of setae of dorsal plate of segment 1, and all lateral trunk setae inverted, with bases of triangles anterior; setae attached at their anterior ends, except for anterior row of plate on segment 1. Segment 1 without lateral setae; seg-

ment 2 with 1 lateral seta of modified type, and 1 biramous bristle; segments 3 and 4 with a pair of lateral setae on each side; segment 5 with a single lateral seta. Four pairs of trichrobothria present; those of segment 4 (third pair) strongly clavate, with club bearing apically a plumose filament about equal to stalk of trichobothrium in length, total length somewhat less than that of other trichobothria; those of segments 2, 3, and 5 filamentous, loosely plumose apically, all subequal in length.

Legs. Eight pairs of legs present, all 5-segmented; coxa and trochanter each with an annulated seta, tarsus with 3 setae; claw slender, pulvilli apparently each with a single bristle.

Type: *Deltopauropus luteus* MacSwain and Lanham.

Deltopauropus luteus MacSwain and Lanham, new species

Male: Color yellowish-white; length 0.56 mm., width 0.24 mm.

Antennae. Stylus latior slightly wider than stylus angustior at tip, tip obtusely conical, approximately one-third again as wide as base; stalk of globulus approximately as long as diameter of globulus; stylus angustior widest near tip, its flagellum approximately one-fourth longer than anterior flagellum of stylus latior.

Trunk. Tergal plate of segment 1 suboval in outline. Tergal plates without ground sculpture, except for indistinct median row of translucent platelets. Lateral platelets (those which bear lateral setae) of segments 2-5 entire. Modified setae of tergal plates triangular to subtriangular. First pair of trichobothria inserted alongside anterior lateral setae of segment 2, second pair between lateral setae of segment 3, third pair alongside posterior lateral setae of segment 4, fourth pair a considerable distance behind lateral setae of segment 5. Penes slightly constricted near middle, base not much widened, apical portion subconical, bristle slightly subapical.

Pygidium. Anal plate with basal portion expanded, trilobed, distal portions consisting of short, very strongly capitate hairs; sternum with posterior setae (b^1) slender, about half again as long as process of anal plate; styli short, appearing as tubercles bearing short apical bristles; tergum with anterior pair of slender setae (d^1) and with 1 anterior lateral seta (d) of modified scale-type, on each side, lateral seta (a^3) slender, slightly longer than the modified, scale-type intermediate setae (a^2).

Female: Similar to male; length 0.50 mm., width 0.26 mm.

Holotype, adult male (No. 5893, Calif. Acad. Sci., Ent.): south slopes of Mt. Diablo, Contra Costa County, California, 12 November 1947, under fallen oak branches (MacSwain and Lanham). *Allotype,* adult female (No. 5894, Calif. Acad. Sci., Ent.): same data as holotype. *Paratypes:* 19 adult males, 64 adult females, same data as holotype; 3 adult females, Fairfax, Marin

County, California, 24 November 1947 (MacSwain and Lanham). Additional material includes immature stages, with same data as holotype, classified as follows: 11 with 6 pairs of legs, 10 with 5 pairs, 3 with 3 pairs of legs. Also, there are many individuals, both adult and immature, preserved in alcohol, from the Mt. Diablo and Fairfax localities.

Deltopauropus magnus MacSwain and Lanham, new species

Male: Color yellowish-white; length 0.75 mm., width 0.34 mm. Very similar to *D. luteus*, differing as follows: size larger, about one-third longer, and relatively wider, more robust; modified setae of dorsum relatively larger, most setae departing more from triangular shape, being more rounded, or even subquadrate; anterior margin of tergal plate of segment 1 and of segment 5 more convex; penes constricted near base, apical portion twice as long as wide, distal half conical.

Female: Similar to male; length 0.76 mm., width 0.32 mm.

Holotype, adult male (No. 5895, Calif. Acad. Sci., Ent.): WOOLSEY CANYON, BERKELEY, ALAMEDA COUNTY, CALIFORNIA, 21 November 1947 (MacSwain). *Allotype*, adult female (No. 5896, Calif. Acad. Sci., Ent.): same data as holotype. *Paratypes:* 4 adult males, 3 adult females, same data as holotype; 11 adult males, 8 adult females, same locality as holotype, 26 November 1947 (MacSwain). Additional material includes 22 immature specimens, all from Woolsey Canyon, 26 November 1947 (MacSwain); these are classified as follows: 9 specimens with 6 pairs of legs, 12 with 5 pairs, 1 with 3 pairs.

The three genera just described are compared with each other and with *Brachypauropus* Latzel in the following key.

KEY TO THE GENERA OF THE BRACHYPAUROPODIDAE OF THE WORLD.

1. Segment 5 (which bears third pair of trichobothria) with 4 tergal plates. Apparently always with 9 pairs of legs and 5 pairs of trichobothria in adult stage.....*Brachypauropus*
–. Segment 5 with 1 or 2 tergal plates. Eight pairs of legs and 4 pairs of trichobothria in adult stage.....2
2. Segment 5 with 2 tergal plates; lateral setae of segment 5 incorporated into lateral margins of tergal plates.....*Zygopauropus*
–. Segment 5 with 1 tergal plate; lateral setae of segment 5 not incorporated into lateral margin of tergal plate, but lying some distance from it.....3

3. Setae of dorsum highly modified to form triangular or subtriangular scales with sculptured surface; tergum of segment 4 (which bears third, or modified, pair of trichobothria) with 4 plates ..... *Deltopauropus*

–. Setae of dorsum bristle-shaped, or at most slightly hastiform; tergum of segment 4 with 2 plates ..... *Aletopauropus*

The genera *Zygopauropus*, *Aletopauropus*, and *Deltopauropus* possess characters in common which sharply separate them from *Brachypauropus*, the only genus previously known in the family. These differences may be summarized as follows: only 5 trunk segments, 8 pairs of legs, 4 pairs of trichobothria; segment 5 with a single lateral seta; pygidium with an additional row of 4 anterior setae. However, this entire set of characters has been found in the last larval (16-legged) instar of *Brachypauropus tuberosus* Remy (1936:319). The possibility that all the specimens of the family Brachypauropodidae obtained for this study were immature must be considered. However, this possibility seems very remote in view of such considerations as the relatively large numbers of individuals obtained, the fact that all earlier instars were represented, that the male genitalia were well developed, and that normal 18-legged adult individuals of another family, the Eurypauropodidae, were collected at the same times and places. Unfortunately, the possession of male genitalia is no certain indication of maturity, since Hansen (1902:336) has stated that "In immature males with eight pairs of legs I have found the organs smaller and less developed than in the adults; in one species, *Paur. spinifer*, of which I only possess an immature male, the organs are as large as in adult males of several other species, nevertheless they are scarcely arrived to full development." In *Deltopauropus* the case for regarding the fourth stage (16-legged forms) as adults seems to be established with a high degree of certainty. First, several hundred individuals were examined without finding one with nine pairs of legs. Secondly, each large colony was divisible into smaller groups composed of two or more fully pigmented 16-legged individuals and several 6, 10, and 12-legged unpigmented individuals, suggesting family groups. Finally, the 16-legged individuals differed from all preceding stages in that they possessed either well developed male genitalia or a band of white powdery substance on the posterior border of the head; these two categories are assumed to be adult males and females, respectively.

The number of legs present in the adult stage of some Old World species may be open to question. The specimens upon which the description of the type species of the genus *Brachypauropus* was based, *B. hamiger* Latzel (1884), had only eight pairs of legs, which together with the fact that no male genitalia were observed on any specimens, led Latzel to believe that his specimens were immature. However, *B. tuberosus* Remy (1936) was described as having nine pairs of legs.

The last larval instar of *B. tuberosus* differs from the supposed adult stage of the three New World genera in the fact that the tergal plate of segment 5 is subdivided longitudinally and transversely into four parts, whereas it is entire or is divided longitudinally into two parts in the New World genera. Therefore, even if the genera described here are based on immature specimens, they are adequately distinct from *Brachypauropus*.

On the basis of the foregoing observations and the present incomplete knowledge of the family Brachypauropodidae the authors prefer to include the genera *Deltopauropus*, *Zygopauropus*, and *Aletopauropus* in this family rather than to consider them a separate group. It would appear that these three genera have evolved their common characters through the development of precocious sexual maturity in the fourth instar and consequent loss of the fifth. Variability in number of instars is not unknown in the class, since certain species of Pauropodidae which have ten pairs of legs also have one more than the normal number of instars.

Family Eurypauropodidae Ryder

This family is characterized by having the tergal plates broadly expanded, concealing the head, legs, and pygidium.

Eurypauropus californicus MacSwain and Lanham, new species

Male: Color dark chestnut brown. Length 1.20 mm., width 0.65 mm.

Head. Four setae present between antennal insertions.

Antennae. Scape 4-segmented, segment 2 shortest, segment 4 longest. Stylus latior slightly longer than last two segments of scape taken together, only slightly widened apically, anterior margin longer than posterior margin; stalk of globulus approximately one-half length of stylus, longer than unsegmented portion of either flagellum; stylus angustior conspicuously shorter than stylus latior, unsegmented portion of its flagellum approximately one-third length of stylus; stalk of secondary gobulus, on segment 3 of scape, approximately one-fourth length of nearest seta, inserted adjacent to seta.

Trunk. Terga with large, setose, evenly spaced tubercles on background of more numerous, much smaller, non-setose tubercles, connected by indistinct lines; large tubercles forming serrate margins of terga, those of dorsum oval in outline, and with seta short, hardly twice length of longest diameter of tubercles; all setae bristle-shaped; large tubercles lacking on anterior one-third of terga 2-5, each tergum with 4 small clusters of non-setose tubercles of intermediate size. Tergum 1 distinctly narrower than 2, biconvex in outline, anterior margin more strongly curved, so that line joining ends of posterior margin lies two-thirds to three-fourths distance from anterior to posterior margin; tergum 2 with anteriorly projecting tooth just mesad of each anterior corner, near insertion of trichobothrium; lateral margin with approximately 20 setose tubercles; terga 3-5 with U-shaped lateral notches near insertions of trichobothria, which are slightly deeper than wide, those of tergum 6 shallower and wider; tergum 6 with posterior margin slightly concave, concave portion with 8 weakly setose tubercles. Trichobothrium of segment 4 distinctly but not strongly clavate, apparently glabrous, somewhat shorter than others; trichobothria of segments 2 and 3 filamentous, apical portions very fine and plumose, those of segments 5 and 6 filamentous, glabrous, all except those of fourth segment subequal in length.

Legs. First and ninth pairs of legs 5-segmented, all others 6-segmented, the metatarsal suture being quite distinct; claw with two auxiliary bristles; trochanter with a single biramous hair, tibia and tarsus each with a short, simple seta on distal margin, metatarsus with two simple setae near apex, 5-segmented legs having tarsus with 3 setae.

Pygidium. Anal plate with basal portions separate, expanded, distal portions cuneate, tips widest, broadly rounded, lateral corners with a small process; sternum with posterior setae (b^1) slender, half again as long as anal plate, lateral setae (b^2) subequal to posterior setae, anterior setae (b^3) slender, short, inconspicuous; styli cylindrical, approximately one-half as long as a^2, clavate; tergum with submedian setae (a^1) spirally crooked, slender, longer than a^2, intermediate setae (a^2) moderately stout, approximately one-half length of lateral setae (a^3).

Female: Similar to male; length 1.44 mm., width 0.62 mm.

Holotype, adult male (No. 5891, Calif. Acad. Sci., Ent.): Woolsey Canyon, Berkeley, Alameda County, California; 21 November 1947 (MacSwain). *Allotype*, adult female (No. 5892, Calif. Acad. Sci., Ent.): same data as holotype. *Paratypes:* 2 adult

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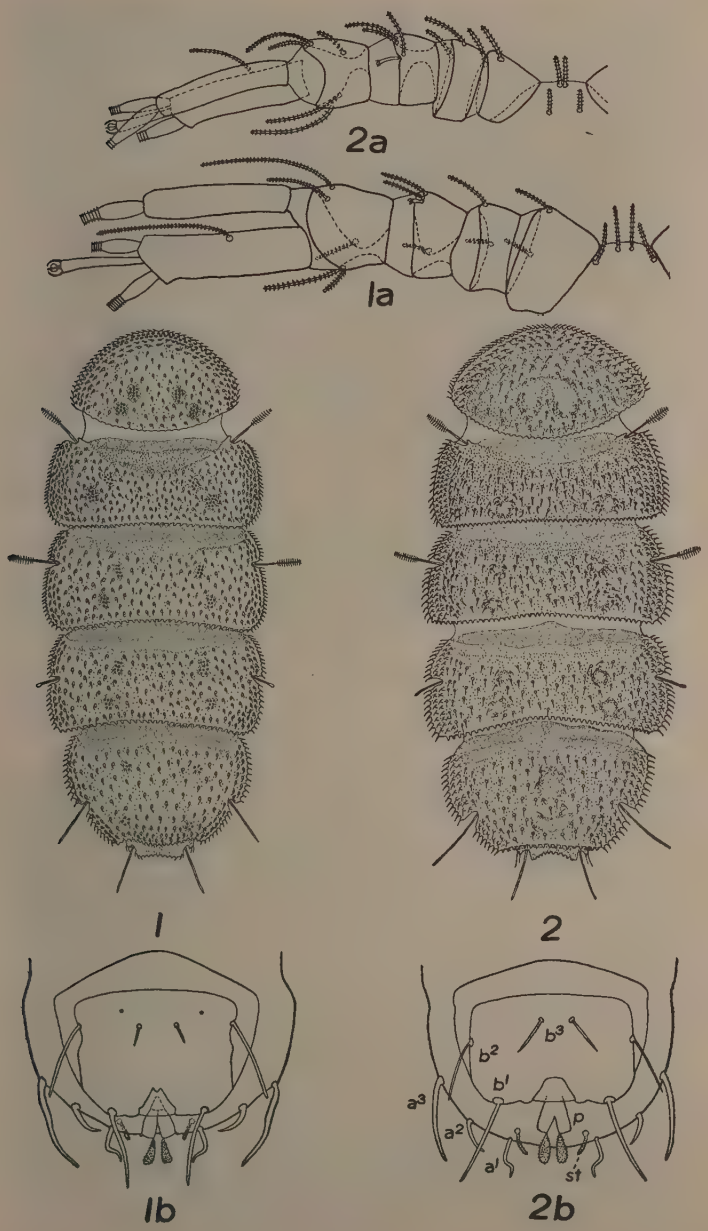
Plate II: Fig. 1, *Eurypauropus californicus*, dorsal view, paratype male x 50; 1*a*, antenna x 350; 1*b*, ventral view, pygidium x 350; Fig. 2. *Gravieripus armatus*, dorsal view, holotype male x 50; 2*a*, antenna x 350; 2*b*, ventral view, pygidium x 350.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males, 4 adult females, same data as holotype; 3 adult males, 7 adult females, same locality as holotype, 26 November 1947 (MacSwain); 8 adult males, 9 adult females, Fairfax, Marin County, California, 24 November 1947 (MacSwain and Lanham). Additional material includes 4 immature specimens with same data as allotype (with 5 terga and 6 or 8 pairs of legs), and many individuals, both adult and immature, preserved in alcohol, from Fairfax and Berkeley.

Individuals of this species were never observed to roll up tightly into a ball when disturbed.

Following the classification of Remy (1937), this species is to be assigned to the genus *Eurypauropus*, since the pulvillus bears two bristles. The three European species, *E. consobrinus* Remy, *E. hastatus* Attens, and *E. ornatus* Latzel, differ by having leaf-shaped or flattened setae on the tergum, especially at the lateral margins; all tergal setae in *E. californicus* are bristle-shaped. *E. spinosus* Ryder, recorded from several localities in the eastern United States, lacks the strong tooth near the insertion of the trichobothrium on the second segment. *E. okinoshimensis* Esaki, of doubtful position, also lacks this tooth, and differs further in the outline of the sixth tergum, and in the fact that all legs are 5-segmented.

Gravieripus armatus MacSwain and Lanham, new species

Male: Color pinkish brown. Length 1.46 mm., width 0.66 mm.

Head. Four setae present between antennal insertions.

Antennae. Scape 4-segmented, segment 2 shortest. Stylus latior about as long as last 2 segments of scape taken together, slightly widened apically, anterior margin distinctly longer than posterior, stalk of globulus approximately one-half length of stylus; stylus angustior subequal to latoir, unsegmented portion of its flagellum about one-third length of stylus; stalk of secondary globulus, on segment 3 of scape, approximately one-half length of nearest seta, inserted some distance from seta.

Trunk. Terga ornamented with larger, setose tubercles on background of much smaller, more numerous non-setose tubercles; terga 1 and 5 with median areas clear of large setose tubercles, tergum 2 with 2 small lateral circular areas and terga 3 and 4 each with 4 lateral circular areas also free of large tubercles; tubercles and setae giving lateral margins of terga serrate outline; setae long, slender, bristle-shaped. Tergum 1 biconvex in outline, so that a transverse line joining widest points would lie three-fifths to two-thirds of distance from anterior to posterior margin; tergum 2 with strong, anteriorly projecting tooth just mesad of anterior corners,

near insertion of trichobothrium; terga 3-6 each with a U-shaped lateral notch at insertions of trichobothria, which in terga 3-5 is usually slightly deeper than wide; tergum 5 with median hump approximately three-fourths distance towards posterior margin; tergum 6 less than half width of 5, projecting only slightly beyond 5, posterior margin strongly concave anteriorly, strong lateral notches lying close to concavity, two long setae just outside notches. Trichobothrium of segment 4 shorter and thicker than others, apparently glabrous throughout, apical third darkened by reason of inclusions, perhaps very slightly swollen; remaining trichobothria filamentous, those of segments 2 and 3 with apical third distinctly plumose; trichobothria of segments 2, 3 and 6 subequal, of segment 5 slightly longer than others.

Legs. All legs 5-segmented, (although tarsus occasionally has faint external creasing at the same point where metatarsal division occurs in those genera having 6-jointed legs) : claw single, with two auxilliary bristles; trochanter with a single, two-branched hair, tibia with one and tarsus with three simple setae. Penes asymmetrical, conical, longer than wide, tips rounded, each with slender subapical seta.

Pygidium. Anal plate with basal portions distally separate, united near base, expanded, distal portions oblong-elliptical, widest near apices; sternum with posterior setae (b^1) slender, approximately twice as long as median process of anal plate, lateral setae (b^2) slightly longer than anterior setae (b^3). Styli cylindrical, about two-thirds length of a^2; tergum with submedian (a^1) spirally crooked, intermediate (a^2) and lateral (a^3) setae all slender, bristle-shaped, a^3 longer than a^1, a^2 shorter than a^1.

Female: Similar to male; length 1.4 mm., width 0.64 mm.

Holotype, adult male (No. 5889, Calif. Acad. Sci., Ent.) : canyon on south slope of Mt. Diablo, Contra Costa County, California, 12 November 1947, under fallen oak branches (MacSwain and Lanham). *Allotype*, adult female (No. 5890, Calif. Acad. Sci., Ent.) : same data as holotype. *Paratypes:* 4 adult males, 1 adult female, same data as holotype; 2 adult males, same locality, from litter under Toyon bush (*Photinia arbutifolia* Lindl.), 4 November 1947 (MacSwain). Additional material includes 13 immature specimens, with same data as holotype, and 1 immature specimen from litter under redwood trees, Redwood Regional Park, near Oakland, Alameda County, California, 2 November 1947 (Lanham). The immature specimens may be classified in respect to number of terga and pairs of legs as follows: 7 specimens with 5 terga, 8 pairs of legs; 3 specimens with 5 terga, 6 pairs; 2 specimens with 4 terga, 5 pairs; 3 specimens with 3 terga, 3 pairs of legs.

When disturbed, individuals of this species moved away, and were never observed to roll up tightly into a ball.

Following the classification of Remy (1937), this species falls in the genus *Gravieripus*, by reason of the 5-segmented legs and the antennal characters. *Gravieripus* previously contained only the single species, *G. latzeli* (Cook), of Europe, which is the *Eurypauropus spinosus* Ryder of Latzel (1884:34). *G. armatus* differs from *latzeli*, as figured by Remy (1937), in lacking leaf-shaped setae on the margin of tergum 4, in the non-clavate trichobothrium of segment 4, and in the expanded basal portion of the processes of the anal plate (linear in *latzeli*). Remy mentions no teeth near the anterior corners of tergum 2, a conspicuous feature of *armatus*. The Japanese *Eurypauropus okinoshimensis* Esaki (1934), of uncertain position in Remy's classification, but having all legs 5-segmented, also lacks the teeth of tergum 2, and has tergum 6 much larger than in *armatus*, and of different outline. The combination of characters such as teeth of tergum 2, the bristle-like setae on the terga (none strongly hastate or leaf-like) also separates *armatus* from the previously described species of *Eurypauropus*, as defined by Remy.

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AN ANNOTATED LIST OF THE CULICIDAE OF WASHINGTON

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The present paper is an annotated list of 31 species of Culicidae known from Washington. Of these, 24 species have been collected by the author mostly during the past two years and mostly within a 50-mile radius of Seattle. Localities and dates are given and generalizations on the biology of the different species are made from field notes taken by the author. Localities and dates of other authors are given, but their remarks on habits have been omitted except in a few indicated cases.

The mosquitoes in Washington are not of great importance as vectors of disease. However, encephalitis is endemic in the Yakima Valley and *Culex tarsalis* Coq. has been demonstrated as the chief vector of this disease. *C. pipiens* L. and *Culiseta inorata* (Will.) are considered vectors of possible importance when found in sufficient numbers (11). *Anopheles freeborni* Ait. is the only vector of malaria in the state, but this disease has been infrequent during recent years (10). Mosquitoes also present a serious pest problem in many areas. *Aedes lateralis* Meig. and *A. vexans* (Meig.) are extremely bothersome near rivers following flooded conditions. *Culex pipiens* L. is a serious pest in residential areas of Seattle and Tacoma where control measures are found necessary. The mosquitoes of mountainous areas cause great annoyance to vacationists. Such mosquitoes as *Aedes nearcticus* Dyar attack viciously during the day along the higher mountain trails. Other recreational areas are spoiled by the number of mosquitoes present. Stage (18) reports *A. aboriginis* Dyar and *A. fitchii* (F. and Y.) as being troublesome around summer homes on Bainbridge Island. *A. cinereus* (Meig.) and *A. varipalpus* (Coq.) are also important in this respect in restricted areas. The author found *A. dorsalis* (Meig.) extremely annoying at Soap Lake and Dry Falls, and they are probably as bad in other areas where they occur. Most of the mosquitoes found in the state are probably occasionally annoying, but are usually limited in their range and numbers.

In identification of material, keys by Matheson (13) and Gjullin (9) were found helpful. However, in a few cases certain characteristics, not included in these keys, were found useful. In the larvae of *Culiseta inornata* (Will.) the tuft on the posterior margin of the plate was found to be double and quite heavy while in the larvae of *C. incidens* (Thom.), which is very similar, this hair is occasionally triple, shorter, and noticeably less robust. In the adults the white tarsal bands of *C. incidens* (Thom.) are frequently indistinct, but the adults of this species are easily distinguished from *C. impatiens* (Walk.), which it closely resembles, by the much heavier wing spots.

Matheson (13) considers *Aedes aloponotum* Dyar as being indistinct from *A. excrucians* (Walk.). However, certain characteristics present on larvae and adults collected during this period seem to warrant leaving this mosquito as a valid species. The larvae closely follow the descriptions of *A. flavescens* (Müll.), differing from *excrucians* in having double lateral hairs on the first to sixth segments, the lower head hairs usually double, but occasionally triple, and the upper head hairs triple and occasionally in fours. One to two terminal pecten teeth are more widely separated than the others and are nearly thornlike in appearance. The body is densely covered with small spicules. The adults closely resemble Dyar's (1) type description. The male genitalia differ from the description of *excrucians* in having a small bifurcation at the tip of the claw of the clasper and having what appears to be a sub-basal lobe. The apical lobe is longer than it is in *excrucians*.

Aedes aboriginis Dyar has been omitted from the key to larvae by Matheson (13). The larvae of *aboriginis* key out to the couplet containing *pullatus, pionips,* and *canadensis* in this key. *Pullatus* has long, pointed anal gills and occurs in the high mountains; *aboriginis* has shorter gills, little longer than the anal segment, and is found in the low coastal regions. *Pionips* and *canadensis* have not been recorded from the state, but *aboriginis* differs from these in not having slipper shaped comb scales and with more or less equal spines on these scales.

Aedes lateralis Meig. has been omitted from the key to adult *Aedes* by Gjullin (9), but can be found in Matheson's key.

Localities are listed by counties with dates for each collection following the specific locality. Larval collections are noted by (L)

and adult collections by (A) after the date of collection. Numbers following some of the localities correspond to references in the bibliography. Records from mosquitoes in the possession of M. K. Mondala are indicated by his name.

The preparation of this paper has been carried out under the general supervision of Dr. M. H. Hatch of the University of Washington, whose guidance and help in preparation of the manuscript is greatly appreciated. The author also wishes to acknowledge the help of Dr. F. F. Fergusen, and Mr. J. J. Davis, of the University of Washington, and Mr. M. K. Mondala of the Washington State Department of Health for the use of material.

Annotated List of Species

1. *Eucorethra underwoodi* Underwood. Probably breeds throughout the year, frequently in deep, cold pools. GRAYS HARBOR CO.: Hoquiam 5-27-17 (6); KING CO.: Paradise Lake 3-31-46 (L). Seattle 2-8-47 (L); MASON CO.: Lake Cushman 6-21-17 (6); SNOHOMISH CO.: Chase Lake 5-8-46 (L); THURSTON CO.: Olympia 3-31-94 (6). LARVAL ASSOCIATIONS: *Culiseta morsitans* (Theo.).

2. *Mochlonyx cinctipes* (Coquillett). Fairly common, at least in western Washington. Larvae found in situations similar to *Chaoborus nyblaei* Zett. KING CO.: Echo Lake 3-19-47 (L), 4-8-46 (L), Seattle, 2-1-47 (L), 2-8-47 (L), 2-16-47 (L), 3-1-47 (L), 3-19-47 (L), 4-18-46 (L), Tukwila 5-5-46 (L); SNOHOMISH CO.: Alderwood Manor 3-1-47 (L). LARVAL ASSOCIATIONS: *Chaoborus nyblaei* Zett., *Aedes aloponotum* Dyar., *A. aboriginis* Dyar., *A. cinereus* (Meig.).

3. *Chaoborus nyblaei* Zetterstedt. Very common, breeding chiefly in deep pools, marshes, and lake edges. Probably breeds throughout the year. Larvae feed extensively on Copepods. KING CO.: Echo Lake 3-19-47 (L), 4-8-46 (L), Seattle 1-11-47 (L), 2-16-47 (L), 3-19-47 (L), 4-18-46 (L), Tukwila 5-5-46 (L); KITSAP CO.: Bremerton (6); MASON CO.: Hoodsport 5-6-24 (6); SNOHOMISH CO.: Edmonds 3-22-47 (L). LARVAL ASSOCIATIONS: *Mochlonyx cinctipes* (Coq.), *Aedes aloponotum* Dyar, *A. aboriginis* Dyar, *A. cinereus* (Meig.).

4. *Anopheles punctipennis* Say. Found to be fairly common in the southwestern area. Larvae collected generally in open, perma-

nent, grassy-edged ponds. GRAYS HARBOR CO.: Malonne 7-5-47 (L), Oakville 7-5-47 (L); KING CO.: Carnation 6-12-47 (A), Kennydale 6-15-46 (L); PIERCE CO.: Ashford 8-5-06 (4), Tacoma 6-22-47 (L); THURSTON CO.: McKenna 7-5-47 (L), Rochester 7-5-47 (L); WHATCOM CO.: Custer 3-29-47 (A). Gjullin and Yates (10) give the following additional counties: CHELAN, CLALLAM, CLARKE, COLUMBIA, COWLITZ, GARFIELD, KITITAS, LEWIS, MASON, OKANOGAN, SPOKANE, WALLA WALLA, WHITMAN, YAKIMA. LARVAL ASSOCIATIONS: *Culex apicalis* Say, *C. tarsalis* Coq., *C. pipiens* L.

5. *Anopheles freeborni* Aitken. One collection taken from a permanent, open, grassy pond. KITITAS CO.: Ellensburg 8-11-46 (L). Gjullin and Yates (10) give the following additional counties: ASOTIN, BENTON, CLALLAM, CLARKE, COLUMBIA, COWLITZ, OKANOGAN, SKAMANIA, SPOKANE, STEVENS, WALLA WALLA, WHATCOM, WHITMAN, YAKIMA. LARVAL ASSOCIATIONS: *Culex tarsalis* Coq.

6. ANOPHELES OCCIDENTALIS Dyar and Knab. Rare. STEVENS CO.: Valley (10); WHATCOM CO.: Lake Whatcom 5-31-17 (L) (1)[1].

7. AEDES NIGROMACULIS (Ludlow). YAKIMA CO.: Yakima Valley (A) (14).

8. AEDES FITCHII (Felt and Young). Larvae generally collected from grassy, open habitats. CLALLAM CO.: Port Angeles 4-20-46 (L); GRANT CO.: Dry Falls 5-11-46 (L); ISLAND CO.: Deer Lagoon, Whidbey Is. 3-28-47; KING CO.: Bothel 4-22-46 (L), Seattle 4-15-46 (L), 4-19-46 (L), 4-27-46 (L); KITITAS CO.: Cle Elum 3-25-47 (L); KITSAP CO.: Bainbridge Is. Late May to June 22, 1932 (15); MASON CO.: Hoodsport (L) (5), Lake Cushman 6-7-17 (4). LARVAL ASSOCIATIONS: *Aedes aloponotum* Dyar, *A. increpitus* Dyar, *A. aboriginis* Dyar, *A. cinereus* (Meig.).

9. AEDES ALOPONOTUM Dyar. Larvae found in a flooded, semi-open pond and nearby marshy areas. Adults captured while attacking in early evening. KING CO.: Seattle 3-19-47 (L), 4-15-46 (L), 4-19-47 (L), 4-27-46 (L), 5-4-46 (L), 6-12-46 (A), 7-31-47 (A); MASON CO.: Hoodsport 7-6-20, 7-7-20 (A) (2), Lake Cushman 6-28-17 (A) (1), 7-3-20, 7-4-20, 7-5-20 (A) (2); PIERCE CO.: Ashford 8-1-06 (A) (2); SKAGIT CO.: Mt. Vernon 3-28-47

[1]This should be considered a doubtful record because Dyar lost the larvae before confirmation of his field identification.

(L); WHATCOM CO.: Custer 4-20-47 (L). LARVAL ASSOCIATIONS: *Aedes fichii* (F & Y), *A. aboriginis* Dyar, *A. cinereus* (Meig.), *Mochlonyx cinctipes* (Coq.), *Chaoborus nyblaei* Zett.

10. AEDES INCREPITUS Dyar. Larvae collected from flooded meadows and grassy marshes. Quite common. Larvae appear very early in spring. Adults caught while biting in wooded areas during the day. GRANT CO.: Park Lake 5-11-46 (A); ISLAND CO.: Deer Lagoon, Whidbey Is., 3-28-47 (L); LINCOLN CO.: Creston 6-1-44 (Mondala); MASON CO.: Lake Cushman 6-27-17 (A) (1); SNOHOMISH CO.: Edmonds 2-16-47 (L), 3-1-47 (L), 3-8-47 (L), 3-16-47 (L), 3-22-47 (L); SPOKANE CO.: Spokane 7-12-17 (4); STEVENS CO.: Chewalah 6-10-44 (Mondala), Kettle Falls 6-10-44 (Mondala); YAKIMA CO.: Yakima Valley (A) (14). LARVAL ASSOCIATIONS: *Aedes fitchii* (F&Y), *A. aboriginis* Dyar.

11. AEDES CAMPESTRIS Dyar & Knab. One collection of larvae taken in the grassy edges of a semi-permanent lake. Adults captured while biting in bright sunlight. GRANT CO.: Lower Coulee 5-3-47 (L), Dry Falls 5-4-47 (A).

12. AEDES DORSALIS Meigen. Larvae found in grassy, temporary pools. One collection taken from slightly alkaline water. Adults caught while biting in the evening. GRANT CO.: Soap Lake 5-3-47 (L), 5-11-46 (A, L); KING CO.: West Seattle 8-11-06 (4), Seattle 6-30-17 (A) (1); OKANOGAN CO.: Oroville 6-6-19 (4); PIERCE CO.: Tacoma 6-30-46 (L); WHATCOM CO.: Bellingham 5-31-17 (A) (1); YAKIMA CO.: Morse Creek 7-19-47 (A), Moxee 8-14-44 (Mondala), Naches 8-14-41 (Mondala). LARVAL ASSOCIATIONS: *Culex tarsalis* Coq., *C. pipiens* L., *Culiseta inornata* (Will.).

13. AEDES ABORIGINIS Dyar. Common, but apparently restricted to western Washington. Larvae usually found in edges of open marshes and deep-sided, grassy-edged, temporary pools. Probably the earliest appearing larvae in the spring. Adults found attacking in wooded areas during the day and early evening. GRAYS HARBOR CO.: Hoquiam 5-27-04 (A) (1); ISLAND CO.: Deer Lagoon, Whidbey Is. 3-28-47 (L); KING CO.: Bothel 3-1-47 (L), Newcastle 3-24-47 (L), Seattle 2-15-47 (L), 2-16-47 (L), 3-1-47 (L), 3-19-47 (L), 5-5-46 (A); KITSAP CO.: Bainbridge Is. April, 1932 (16), Bremerton, last of April, 1924 (L) (5), Kingston 6-2-46 (A); MASON CO.: Lake Cushman 6-26-17, 6-27-17 6-28-17 (5); PIERCE CO.: Ashford 8-1-06 (A) (5), Longmire 5-10-47 (L), 6-17-17 (L) (5), Yelm 6-1-46 (A); SKAGIT CO.: Conner 3-28-47

(L), Mt. Vernon 3-28-47 (L); SNOHOMISH CO.: Alderwood Manor 3-1-47 (L), Chase Lake 3-1-47 (L), Edmonds 2-16-47 (L), 3-1-47 (L), 3-8-47 (L), 3-16-47 (L), 3-22-47 (L), 4-19-47 (L), 6-9-46 (L); WHATCOM CO.: Glacier 6-3-17 (A), Mt. Baker (foot) (5). LARVAL ASSOCIATIONS: *Mochlonyx cinctipes* (Coq.), *Chaoborus nyblaei* Zett., *Aedes fitchii* (F&Y), *A. aloponotum* Dyar, *A. increpitus* Dyar, *Culiseta impatiens* Dyar.

14. AEDES COMMUNIS (De Geer). PIERCE CO.: Mt. Rainier, Indian Henry's 6-13-17 (L) (1), Mt. Rainier 8-3-06 (A) (1).

15. AEDES HEXODONTUS Dyar. Apparently restricted to high mountainous regions. Larvae collected from a grassy pool at the foot of a snow bank. PIERCE CO.: Chinook Pass 8-10-46 (L). LARVAL ASSOCIATIONS: *Aedes nearcticus* Dyar, *A. pullatus* (Coq.).

16. AEDES IDAHOENSIS (Theobald). OKANOGAN CO.: Okanogan (4).

17. AEDES LATERALIS Meigen. Very common breeder in the flood-waters of the larger rivers (3). This mosquito has been studied extensively and reported in several papers (20). COWLITZ CO.: 6-13-33 (A) (17), Longview 7-20-44 (Mondala); KING CO.: Lake Tapps 7-14-34 (Mondala); PACIFIC CO.: Oysterville 6-21-18 (4); SKAMANIA CO.: 6-16-33 (A) (17); WHATCOM CO.: Sumas 7-15-20 (1); YAKIMA CO.: Yakima Valley (A) (14).

18. AEDES NEARCTICUS Dyar. Larvae collected from a grassy pool at the foot of a snow bank. Adults fierce biters, found attacking in the open and at late afternoon. Apparently restricted to high mountainous regions. PIERCE CO.: Chinook Pass 8-10-46 (A, L), Mt. Rainier (13). LARVAL ASSOCIATIONS: *Aedes hexodontus* Dyar, *A. pullatus* (Coq.).

19. AEDES PULLATUS (Coquillett). Larvae collected from a grassy pool at the foot of a snow bank and in a deep, sunken valve-box filled with snow-water. Apparently restricted to high altitudes. PIERCE CO.: Chinook Pass 7-20-47 (L), 8-10-46 (L); Olympic National Forest (no county given), 4-19-43 (L) (16). LARVAL ASSOCIATIONS: *Aedes hexodontus* Dyar, *A. nearcticus* Dyar.

20. AEDES VENTROVITTIS Dyar. "Occurs locally at high altitudes north into Washington" (7).

21. AEDES VARIPALPUS (Coquillett). Stage (18) reports finding larvae in an oak stump filled with rain water and Dyar (1)

found them in a similar situation. Females were collected while biting in the evening. Males were caught while swarming around humans along a heavily wooded road during mid-afternoon. KING CO.: Kent 6-20-07 (4), Seattle 5-30-46 (A), 7-31-06 (4); KITSAP CO.: Kingston 6-2-46 (A); LEWIS CO.: Randall 4-12-38 (L) (18); MASON CO.: Lake Cushman 7-4-20 (4); PIERCE CO.: Longmire Springs 6-11-17 (L) (1), Yelm 6-1-46 (A); YAKIMA CO.: American River 8-1-46 (A).

22. AEDES VEXANS (Meigen). Very common breeder in the flood-waters of the larger rivers (3). This mosquito has been studied extensively and reported in several papers (20). YAKIMA CO.: Moxee 8-9-41 (Mondala), Naches 4-14-44 (Mondala), Sunnyside 9-10-41 (Mondala), Yakima 5-24-41 (Mondala); WHATCOM CO.: Sumas 7-15-20 (A) (3). Common along the lower Columbia River (18).

23. AEDES CINEREUS (Meigen). Larvae common in spring and early summer, found generally in shaded, deep-sided ponds with either grassy or naked edges. Adults captured while biting during the day, but in shaded areas. KING CO.: Camp Mason 5-30-46 (A), Echo Lake 3-19-47 (L), Newport 6-15-46 (L), North Bend 5-30-46 (A), Seattle 4-19-47 (L), 4-27-46 (L), 5-4-46 (L), 5-20-46 (L), Tukwila 5-5-46 (L); MASON CO.: Hoodsport (L) (5), Lake Cushman 6-26-17 (1); PIERCE CO.: Mt. Rainier 8-3-06 (4); WHATCOM CO.: Glacier 6-13-17 (L) (1); YAKIMA CO.: Yakima Valley (A) (14). LARVAL ASSOCIATIONS: *Mochlonyx cinctipes* (Coq.), *Chaoborus nyblaei* Zett., *Aedes fitchii* (F&Y), *A. aloponotum* Dyar, *Culex apicalis* Adams, *C. tarsalis* Coq., *C. pipiens* L.

24. CULEX APICALIS Adams. Never abundant. Larvae found generally in the grassy, deeper edges of permanent ponds, marshes, and lakes. One collection of larvae taken from a Sphagnum bog. GRAYS HARBOR CO.: Malonne 7-5-47 (L); KING CO.: Newport 6-15-46 (L), Snoqualmie Pass 8-11-46 (L); SNOHOMISH CO.: Chase Lake 6-9-46 (L), Silver Lake 6-5-46 (L); WHATCOM CO.: Glacier 6-2-17 (L) (1), Sumas 6-2-17 (A) (1); YAKIMA CO.: Naches River 8-11-46 (L). LARVAL ASSOCIATIONS: *Anopheles punctipennis* Say, *Aedes cinereus* (Meig.), *Culex tarsalis* Coq., *Culiseta incidens* (Thom.).

25. CULEX TARSALIS Coquillett. Larvae collected from areas similar to *Culex pipiens* L. Collections also made from alkaline

water. Very common throughout the state. GRANT CO.: Alkali Lake 5-11-46 (L), Coulee City 5-11-46 (L), Soap Lake 5-11-46 (L); GRAYS HARBOR CO.: Hoquiam 5-27-17 (A) (1), Malonne 7-5-47 (L), Oakville 7-5-47 (L); KING CO.: Bothel 4-26-47 (L), 4-27-46 (L), 5-5-46 (L), Kennydale 6-15-46 (L), Renton 5-5-46 (L), Seattle 1-5-47 (A), 5-20-46 (L), 5-30-46 (L), 6-22-17 (A) (1); KITITAS CO.: Ellensburg 8-11-46 (L); LEWIS CO.: Centralia 5-28-17 (A) (1); OKANOGAN CO.: Okanogan 6-13-44 (Mondala); PIERCE CO.: Ashford 6-10-17 (A) (1), Tacoma 6-22-47 (L), Sunrise, Mt. Rainier 8-10-46 (L); WALLA WALLA CO.: Touchet 5-2-42 (Mondala); WHATCOM CO.: Bellingham 5-31-17 (A) (1); YAKIMA CO.: Yakima 8-12-41 (Mondala). LARVAL ASSOCIATIONS: *Anopheles punctipennis* Say, *A. freeborni* Ait., *Aedes dorsalis* (Meig.), *A. cinereus* (Meig.), *Culex pipiens* L., *Culiseta inornata* (Will.), *C. incidens* (Thom.).

26. CULEX PIPIENS Linnaeus. Larvae collected from permanent ponds, marshes, and lake edges, frequently being in areas that dry up later in the summer. Present both in foul and fresh water. Very common pest in western Washington. CLALLAM CO.: Sequim 8-10-44 (Mondala); GRAYS HARBOR CO.: Aberdeen (12); KING CO.: Redmond 4-26-47 (L), Seattle 1-5-47 (A), 1-22-47 (A), 4-7-46 (A), 5-20-47 (L), 6-4-47 (L), 6-23-47 (L); PIERCE CO.: Tacoma 6-22-47 (L), 6-30-46 (L); SNOHOMISH CO.: Edmonds 6-9-46 (L), 7-14-46 (L); YAKIMA CO.: Yakima 8-11-41 and 8-18-41 (Mondala). LARVAL ASSOCIATIONS: *Anopheles punctipennis* Say, *Aedes dorsalis* (Meig.), *A. cinereus* (Meig.), *Culex tarsalis* Coq., *Culiseta inornata* (Will.), *C. incidens* (Thom.).

27. CULISETA MORSITANS (Theobald). One collection made from a Sphagnum bog. SNOHOMISH CO.: Chase Lake 5-8-46 (L); YAKIMA CO.: Yakima Valley (A) (1). LARVAL ASSOCIATIONS: *Eucorethra underwoodi* Und.

28. CULISETA INORNATA (Williston). Common species. Larvae found in a variety of habitats including alkaline, foul, and fresh water, but usually in open areas. CLALLAM CO.: Sequim 6-27-44 (A) (Mondala); GRANT CO.: Soap Lake 5-11-46 (L); OKANOGAN CO.: Okanogan 6-27-44 (Mondala); PIERCE CO.: Tacoma 6-30-46 (L); SNOHOMISH CO.: Edmonds 6-9-46 (L), 6-15-46 (L), 7-14-46 (L); YAKIMA CO.: Yakima Valley (A) (14). LARVAL ASSOCIATIONS: *Aedes dorsalis* (Meig.), *Culex tarsalis* Coq., *C. pipiens* L., *Culiseta incidens* (Thom.).

29. CULISETA IMPATIENS (Walker). Larvae taken from deep-sided marsh pools, and a woodland pool in a dry creek bed. Adults collected off clothing during the day; none biting. KING CO.: Camp Mason 6-1-46 (A); MASON CO.: Lake Cushman 6-26-17 (L) (1); PIERCE CO.: Longmire Springs 6-11-17 (A) (1); SKAGIT CO.: north of Darington 6-29-47 (L); SNOHOMISH CO.: Edmonds 6-9-46 (L); WHATCOM CO.: Glacier 6-3-17 (A).

30. CULISETA INCIDENS (Thomson). Larvae collected from a variety of habitats; Sphagnum bog, meadow, pond, and foul water. Adults were collected while biting. GRANT CO.: Dry Falls Lake 5-4-47 (L); GRAYS HARBOR CO.: Hoquiam 5-27-15 (A) (1); KING CO.: Enumclaw 6-27-44 (Mondala), Greenwater 6-17-44 (Mondala), Paradise Lake 3-31-46 (A), Redmond 4-26-47 (L), Seattle 6-22-17 (A) (1); LEWIS CO.: Centralia 5-28-17 (A) (1); PIERCE CO.: Ashford 6-10-17 (A) (1), Tacoma 6-30-46 (L); SNOHOMISH CO.: Chase Lake 6-9-46 (L), Edmonds 7-14-46 (L); YAKIMA CO.: Yakima Valley (A) (14). LARVAL ASSOCIATIONS: *Culex apicalis* Adams, *C. tarsalis* Coq., *C. pipiens* L., *Culiseta inornata* (Will.).

31. MANSONIA PERTURBANS (Walker). KING CO.: Seattle 7-8-37 (A) (M. H. Hatch collection); YAKIMA CO.: Yakima Valley 7-31-41 (L) (8).

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ON THE CLASSIFICATION OF *TORYMUS*
(Torymidae: Chalcidoidea)

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A search has been made for some diagnostic character by which the species of *Torymus* could be separated with greater certainty.

In the past, such characters as the shape and size of the stigmal knob, the length of the stigmal vein, presence or absence of the crossfurrow on the scutellum, or the differential length of the segments of the antennae, have been used in separating species of the genus *Torymus*. Although these are valuable characters, they are sufficiently variable to make determinations difficult. When these taxonomic characters are used in combination with the male and female genitalia, determinations are simpler.

The shape of the ovipositor saw is sufficiently stable in *Torymus* and varies greatly enough between species that it can be used as a dependable character. This structure has been used before by Phillips and Emery** in the determination of members of the genus *Harmolita* (Chalcidoidea). These authors illustrated the dorsal view of the ovipositor to show different teeth arrangements. They found that in *Harmolita* there is little difference in the ovipositors of the different species as seen in profile; the main difference is in the dorsal view and consists in size, shape, and arrangement of denticles.

Both the dorsal and lateral views of the ovipositor can be used for determination in the genus *Torymus*. Since the saws vary in size, shape, and number of teeth, the lateral view is preferable. The lateral view can be seen in silhouette clearly, whereas in the dorsal view, it is difficult to bring the entire tooth structure into focus. Inasmuch as the ovipositor is higher than wide, the preparation of a dorsal mount is laborious without first removing the two ventral valvulae.

The ovipositor saws of thirty specimens of the same species were stable in the number, arrangement, and size of teeth. Several saws each of ten different species were compared and the characters were found stable for each species. Drawings of the ovipositors of six species are shown in the figures.

* Publication costs paid by the author.
** Phillips, W. J., and W. T. Emery, Proc. U. S. Nat. Mus., 55:433-471, pls. 39-48, 1919.

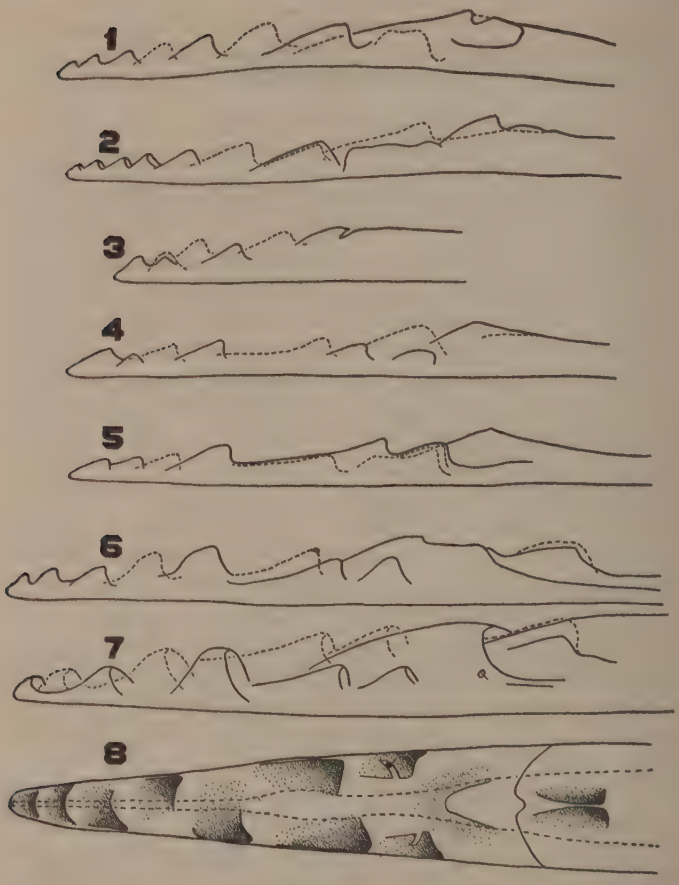

Fig. 1. Ovipositor tip of *Torymus giganticum*, lateral view; Fig. 2. *T. perplexum*, lateral view; Fig. 3. *T. bedeguaris*, lateral view; Fig. 4. *T. chrysochlora*, lateral view; Fig. 5. *T. tubicola*, lateral view; Fig. 6. *T. californicum*, lateral view; Fig. 7. dorso-lateral view; Fig. 8. dorsal view. All x 125.

These drawings were made by projecting the image of the ovipositors with the use of an ordinary microscope tilted horizontally with the eye-piece placed 28 inches from the drawing paper for all illustrations except the three views of *Torymus californicum*. For these drawings the eye-piece was placed at 26 inches.

THE EMBIOPTERA OF NEW GUINEA

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Aside from a few records of immature specimens, the only previously known embiopteron from New Guinea was *Oligotoma albertisi* Navás, described in 1930. Recently, the writer had an opportunity to collect specimens of this order in three widely separated areas along the northeast coast of this island. The fact that seven new species were obtained in limited coastal environments, and that four of these were found in one region, indicates that New Guinea must be rich in species awaiting discovery.

Specimens were obtained by first locating their silken tunnels spun on the bark of coconut palms and forest trees. The usual location of these tunnels is along the contact point of arboreal vines, in bark crevices, under bark flakes or lichens, among roots of epiphytic plants, and on the under surfaces of branches and logs. Habitats along the sea shore seem to be preferred by certain species to those a few yards or more inland. Some species may produce a conspicuous matting of tunnels occupied by a large number of individuals, others only inconspicuous, individual colonies. Tunnels produced by spiders or moths may closely resemble, and be confused with Embioptera activity. Because of the great amount of cover and the profusion of potential habitats in tropical forests, a search in the expected places for colonies may not yield results except after prolonged patience.

Mature males, obtained by carefully dissecting the tunnels, may be killed and preserved in 70% alcohol in the field. However, all immature specimens obtained and females should be transferred alive to large, cotton-plugged test tubes partially filled with crumbled bark or other habitat material. The Embioptera will quickly spin new tunnels in captivity and the tubes can serve as cultures from which an indefinite number of mature males, indispensable for systematic study, may be obtained. The cultures need only be kept moderately moist and enlarged as the populations increase. The bark, lichens, and moss serve as food.

[1]Publication costs paid by the California Academy of Sciences.

The nine known New Guinea species are members of the genus *Oligotoma* wherein they are a part of the large group of species related to *borneënsis* Hagen (= *vosseleri* Krauss). The male genitalic characters in this group are relatively uniform but valuable supporting specific distinctions may be found in mandibular and head structure, size, and in coloration. Color characters of post-teneral individuals, underestimated by Davis (1940), deserve fuller consideration. They are very useful in at least the preliminary separation of species, but should not become the sole characterization of new species.

General Explanation of Figures

The drawings are based on camera lucida outlines of specimens treated in KOH and mounted in balsam. Most setae, indications of pattern, and relative degree of sclerotization have been omitted. Membranous areas are represented by stippling. In the figures of the head the mandibles are often shown spread apart; the palpi, flagellar antennal segments and facets of the eyes have been omitted. No attempt has been made to adopt a uniform scale. Explanation of symbols: 9 = ninth abdominal tergite, 10 L = left hemitergite and 10 R = right hemitergite of tenth abdominal segment. 10 LP = process of 10 L; 10 RP_1 and 10 RP_2 = processes of 10 R. HP = process of hypandrium, LPPT = left paraproct, LC_1 = basal segment of left cercus, LCB = left cercus-basipodite.

Key to Species of New Guinea Embioptera

Mature Males

1. Mandibles without inner-basal excisions; eyes very large, separated by interspace less than one-half an eye-width wide; left paraproct (LPPT) not sclerotized; basal segment of left cercus nearly cylindrical, not thickened distad; size small (body length 6.5 mm.) (fig. 8) ..... *oculata*
–. Mandibles with distinct inner-basal excision; eyes moderate to small sized, interspace at least three-fourths an eye-width wide; left paraproct sclerotized; basal segment of left cercus noticeably to strongly swollen distad; size small to large (body length 8 to 12 mm.) 2
2. Left mandible with the two distal teeth fused; process of left hemitergite of tenth abdominal tergite (10 LP) with a minute but distinct spine on outer margin near apex. (fig. 7) ..... *mandibulata*
–. Left mandible with three distinct, separate, acutely pointed distal teeth; left tergal process (10 LP) without subapical spine.... 3

3. Mandibles with bases very broad, inner basal margins sharply, obtusely angulate, outer dorsal margins strongly, acutely elevated (fig. 1) ..... *borneënsis*
–. Mandibles not exceptionally broad basally, inner basal margins broadly rounded, outer dorsal margins not strongly elevated....4
4. Head color contrastingly darker than remainder of body, or at least the prothorax 5
–. Head and body nearly unicolorous, prothorax not lighter than pterothorax 7
5. Body and legs pale yellowish orange in color throughout in striking contrast to dark brown wings and blackish brown head..*aurea*
–. Body and legs mostly light to dark brown, wings not darker than body 6
6. Prothorax pale yellow in strong contrast to the dark brown legs, pterothorax, and abdomen; wings as dark as pterothorax, hyaline stripes very narrow and sharply defined; eyes relatively small, separated by an interspace more than two eye-widths wide; size large (length 11.0 mm.) ..... *maritima*[2]
–. Prothorax light brown, not noticeably lighter in color than that of legs, pterothorax, and abdomen; wings and pterothorax nearly unicolorous, hyaline stripes broad and poorly defined; eyes large, interspace one eye-width wide; size small (8 mm.) ..... *hollandia*
7. Eyes large, inflated, interspace less than one eye-width wide; head narrow (fig. 2) ..... *davisi*
–. Eyes rather small; interspace nearly two eye-widths wide; head broad (fig. 3) ..... *brunnea*

Mature Females[3]

1. Coxae and trochanters of middle and hind legs whitish, strongly contrasted by the dark femora and thorax 2
–. Legs unicolorous 3
2. Tibiae and tarsi of middle and hind legs whitish; strongly contrasted by the dark brown femora ..... *oculata*
–. Tibiae, except for short basal whitish area, as darkly colored as femora; tarsi golden brown ..... *mandibulata*
3. Head distinctly darker than prothorax 4
–. Head and prothorax unicolorous 5
4. Size larger, 9 to 11 mm. Liki and Wakde Islands ..... *aurea*
–. Size smaller, 7 to 9 mm. Humboldt Bay ..... *hollandia*
5. Head, prothorax, and legs, medium to golden-brown; thorax and abdomen dark brown ..... *maritima*
–. Unicolorous dark brown throughout[4] ..... *davisi*

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[2] *Albertisi* Navás would apparently key out to *maritima* but at least differs in the nature of the apex of the left paraproct which is sharply hooked in the latter and obtusely tapered and scarcely curved outward in *albertisi*.

[3] The females of *albertisi* Navás and *borneënsis* Hagen are unknown.

[4] Females of *brunnea* will probably key out here but available specimens are teneral and therefore not included.

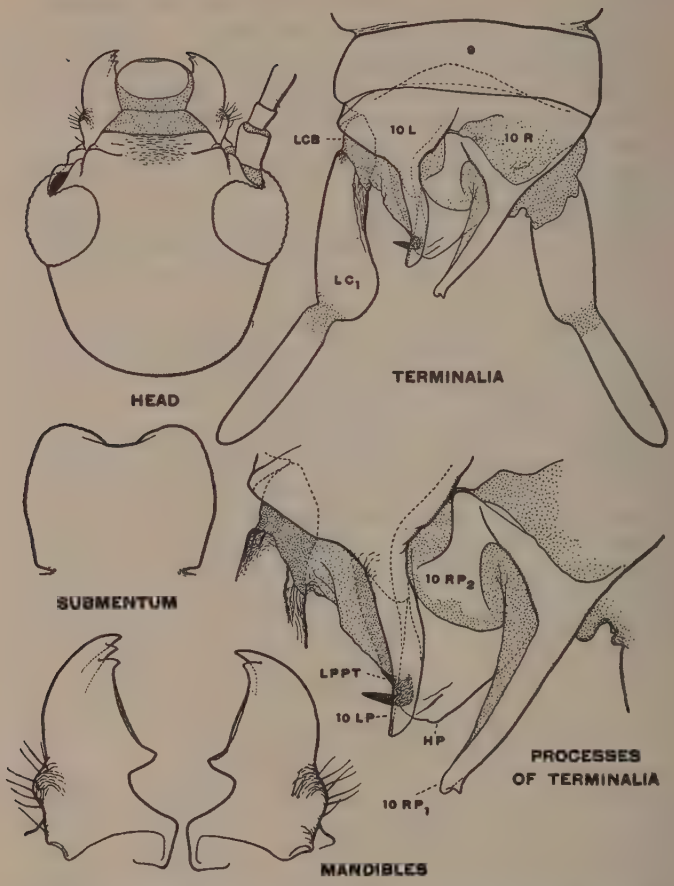

Figure 1. *Oligotoma borneënsis* Hagen. Salient characters of mature male based on specimen from Ta Han, Hainan. Explanation of symbols on page 98.

(1) Oligotoma borneënsis Hagen

A bibliography, redescription, and figures of this common species have been published recently by the writer (1943) and these need not be repeated here. The species is known from South China, the Philippines, through Indonesia, and the Malay Peninsula where

males are frequently collected at light, often together with those of *Oligotoma humbertiana* (Saussure). Because its range is apparently confined to populated coastal areas, it seems evident that the species has been spread by man in the course of ancient and modern commerce. It may be separated from all other known New Guinea species by its peculiar mandibular characters as figured.

New Guinea record: Six males from Sekroe, N. W. New Guinea, acq. 1898 (N. Schadler) (Leiden Museum Collection).

I wish to thank Dr. H. C. Blöte of the Rijksmuseum van Natuurlijke Historie for the privilege of studying these specimens.

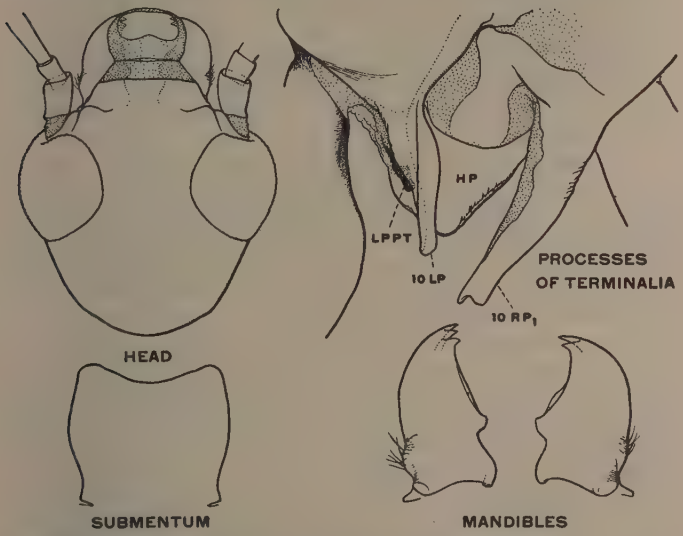

Figure 2. *Oligotoma davisi*, new species. Salient characters of holotype male. Explanation of symbols on page 98.

(2) Oligotoma davisi Ross, new species

Male. General Color: body, legs, and wings uniform medium brown throughout; head slightly darker. *Dimensions:* relatively large, body length 8.5 mm.; forewing length 6.3 mm., breadth 1.75 mm.

Head with form as illustrated. Cranium narrow; area behind eyes dark brown, becoming yellowish brown between eyes, thence dark brown in clypeal region[5]; ventrally dark brown except for

[5]This bicolorous condition only visible in KOH-cleared specimens.

lighter ring around margins of occipital foramen; occipital foramen rounded anteriorly; width of gular bridge equal to submentum length. Eyes very large, inflated, facets very large. Antennae with basal segment dark chocolate-brown, other segments tan, number incomplete. Labrum light brown; mandibles golden yellow except for reddish amber inner-apical margins; palpi dark brown; submentum light golden brown, much lighter than posterior cranial color, outline as figured.

Thorax without specific structural features, medium brown throughout, pleurites darker. *Legs* with all segments unicolorous medium brown, the forelegs somewhat darker. Wings without specific venational features, medium brown throughout but appearing relatively light because of broad unpigmented intervenal stripes which are wider than one-third the distance between veins and have very weak, suffused margins.

Abdomen paler than thorax; terminalia with structure and color almost identical to that of *brunnea* more fully described below.

Female (in alcohol) rather unicolorous blackish brown throughout. Length 11.0 mm.

Head with cranium blackish, chocolate-brown dorsally with two faint suffused pale brown areas between eyes, no evidence of basal pattern; ventrally paler around occipital foramen and gular bridge. Antennae with basal segment as dark as cranium, second segment light brown, remaining segments pale straw-yellow; becoming paler distad; number incomplete (16 present). Labrum colored as cranium; other mouthparts, except mandibles and submentum, dark brown; submentum blackish brown.

Thorax blackish brown dorsally, somewhat lighter ventrally; membranous areas between pronotum and mesonotal acrotergite and between mesonotum and metanotal acrotergite white. *Legs* with all segments dark brown, tarsi paler; membranous area between femur and tibia of all legs whitish.

Abdomen with tergites blackish brown, pleurites and sternites (except terminal) medium brown, membranous areas and posterior margins of tergites rufous light brown; terminal tergites darker, paragenital sternites dark brown without characteristic pattern. Cerci blackish brown.

Holotype male, (No. 5850, Calif. Acad. Sci., Ent.), on slide, and *allotype* female, (No. 5851, Calif. Acad. Sci., Ent.), in alcohol, collected by the writer at TOEM, MAFFIN BAY, DUTCH NEW GUINEA July 20, 1944.

Paratypes: fifteen males (14 on slides, one in alcohol) and eight females on slides and in alcohol from the type locality but collected, or matured in cultures, on various dates from June 20 to September 20, 1944. Deposited in the U. S. National Museum, Museum of

Comparative Zoology, Harvard, British Museum (Natural History), and in the writer's collection.

Biology: Silken colonies were found on the trunks of shaded forest trees. A favored situation is along the contact point of large vines growing on the tree. This is the most abundant of the forest species at Maffin Bay.

Relationships: Males of *davisi*, and its close relative, *brunnea*, described below, may be superficially distinguished from the other known New Guinea Embioptera by their rather uniform color in both sexes, the other species having a paler prothorax, darker wings or bicolorous legs. The male of *davisi* may be separated from that of *brunnea* by its smaller, narrower cranium with very large eyes and its darker color. This species is named in honor of the late Australian embiopterist, Consett Davis, who lost his life in a wartime plane crash in New Guinea.

(3) Oligotoma brunnea Ross, new species

Male. General color: body, legs and wings rather uniform medium brown throughout; head somewhat yellowish-brown. *Dimensions:* relatively large; body length 10.7 mm.; forewing length 7.0 mm., breadth 1.8 mm.

Head with form as illustrated. Cranium yellowish-brown becoming darker at sides; width of gular bridge equal to length of submentum. Eyes relatively small and widely spaced, facets prominent. Antennae with basal segment dark chocolate-brown in strong contrast to lighter cranial color; other segments at first medium brown but gradually becoming pale tan distad; only fourteen segments present, remainder broken off. Labrum medium brown; mandibles golden yellow, inner margins reddish amber; palpi dark brown; submentum dark golden brown, much darker than cranium, outline as figured.

Thorax without specific structural features, medium brown throughout, pleurites somewhat darker. *Legs* with all segments medium brown. Wings without specific venational features, medium brown throughout; unpigmented intervenal stripes rather broad, width averaging one-fourth the distance between veins, margins rather suffused.

Abdomen similar in color to thorax, *terminalia* with structure as figured. Left hemitergite (10 L) of tenth segment medium brown with dark brown inner and outer margins, process (10 LP) golden brown; right hemitergite (10 R) pale brown, processes dark chocolate-brown basally becoming lighter distad, extreme apex of 10 RP_1 golden-yellow. Ninth sternite pale brown; base of process (HP)

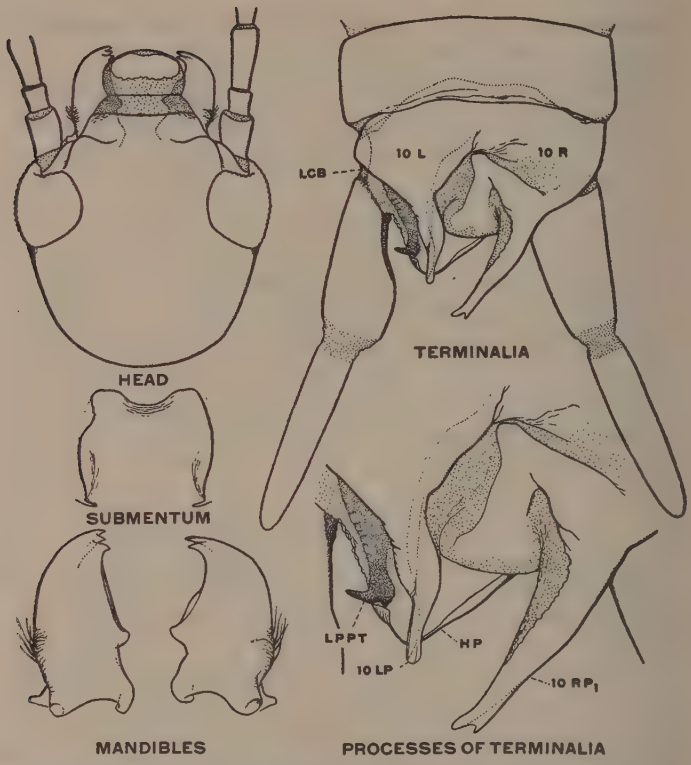

Figure 3. *Oligotoma brunnea,* new species. Salient characters of holotype male. Explanation of symbols on page 98.

transversely rugulose, darker, apex of process with prominent setae; left paraproct (LPPT) light brown, setose, sclerotized apex formed as an obtuse hook with an irregular base, color golden brown; left cercus-basipodite (LCB) very dark chocolate-brown, fused to base of left cercus; basal segment of left cercus medium brown with dark inner margin, terminal segment and segments of right cercus light brown.

Female: The only associated female is teneral and therefore unfit for description. Its characters should be very similar to those of *davisi* but its color may prove to be lighter.

Holotype: male, (No. 5854, Calif. Acad. Sci., Ent.), on slide, collected by the writer at GUSIKA, 15 miles north of FINSCHHAFEN, N. E. NEW GUINEA, April, 1944.

Paratypes: three topotypic males deposited in the U. S. National Museum and in the writer's collection.

Biology: Collected in silken tunnels spun on the exposed under surface of a large fallen tree near a forest creek. Embioptera were rarely found in the forest area at Gusika but were abundant (*maritima*) on the bark of trees growing on the coral cliffs along the ocean shore.

Relationships: Discussed under *davisi*. Further collecting may reveal that the two species, *brunnea* and *davisi*, belong to a race complex. For the present they are regarded as species because of the marked, consistent differences in head form and color.

(4) Oligotoma albertisi Navás

Oligotoma albertisi Navás, 1930, Broteria, Serie Zoologica, 26; 20, fig. 2; Davis, 1940, Proc. Linn. Soc. N.S.W., 65; 375, figs. 38-42.

Holotype: Male, deposited in Genoa Museum, Italy.

Type data: Katau, New Guinea, 1875 (L. M. Albertis).

Davis' recent redescription and illustrations of the type of this species are insufficient in the light of present knowledge to place this species with certainty. It is probably distinct from those described at this time but appears to be most similar to *maritima* by virtue of its head and eye form, and the pale prothorax. It differs, however, in having the left paraproct (LPPT) blunt and unhooked and in the longer left tergal process (10 LP).

It is unfortunate that the nature of the mandibles and details of color were not made known by Davis. His suggestion that *albertisi* might prove to be a subspecies of *borneënsis* does not seem to be well founded.

(5) Oligotoma maritima Ross, new species

Male. General color: Head dark chocolate-brown, much darker than remainder of body; pterothorax, legs, and abdomen medium brown; wings dark brown; prothorax yellowish, contrastingly lighter than any other portion of specimen. *Dimensions:* large; body length 10.4 mm.; forewing length 7.0 mm., breadth 1.9 mm.

Head with form as illustrated. Cranium dark chocolate-brown, somewhat lighter between eyes dorsally and ventrally around inner margins of eyes, dark around margins of occipital foramen; gular bridge width a little more than half of submentum-length. Eyes rather small, widely spaced, with small facets. Antennae with basal three segments as dark as cranium, remaining segments becoming

increasingly lighter brown distad, finally straw-yellow; twenty-two segments present in both antennae (probably complete). Labrum dark brown; mandibles with structure as figured, golden-brown with apical teeth and inner margins reddish-brown; palpi dark brown; submentum with outline as figured, largely dark, chocolate-brown with lateral margins blending to golden-brown.

Thorax without specific structural features; prothorax with dorsum and sides pale straw-yellow, prosternum light brown; pterothorax with scutae medium brown anteriorly and posteriorly, pale medially, pleural sclerites dark brown, sternites medium brown. *Legs* with all segments medium brown, prothoracic legs somewhat darker. Wings without specific venational features; uniformly dark brown with very narrow unpigmented intervenal stripes, these averaging only one-sixth the distance between veins in width, margins regular and sharply defined.

Abdomen medium brown throughout. *Terminalia* with structure as figured; tenth tergite dark brown, right hemitergite (10 R) pale; left process (10 LP) dark brown medially, tan along margins and at apex; processes of right hemitergite dark brown, 10 RP_1 somewhat golden-brown at extreme apex; ninth sternite medium brown, process (HP) tan; left paraproct (LPPT) medium brown, sclerotic hook golden-brown; left cercus-basipodite (LCB) dark brown, apparently fused to base of left cercus; cerci medium brown, basal segment of left cercus slightly darker with dark brown inner margin.

Female (in alcohol) rather unicolorous medium brown throughout; thorax and head lighter, the abdomen darker. Length 14.0 mm.

Head with cranium amber-brown with lighter, characteristic embiopteroid basal pattern visible; ventrally paler amber-brown. Antennae with basal segment dark brown, second and third segments light brown, remainder light yellowish brown; 22 segments present. Labrum pale amber-brown; other mouthparts amber brown, stipes of maxilla and membranes light yellowish brown; submentum dark brown.

Thorax with pronotum dark amber-brown, other segments dark, mottled chocolate-brown; ventrally pale. *Legs* with femora and tibiae dark brown, other segments pale brown mottled with dark brown; membrane between femur and tibia pale.

Abdomen with tergites dark brown; becoming darker caudad; pleurites and sternites mottled yellowish brown; eighth sternite pale medially, dark brown at sides; ninth sternite with a pale basal and terminal triangular area, sides dark brown. Cerci dark brown mottled with small pale areas.

Holotype male (No. 5852, Calif. Acad. Sci., Ent.) and female (No. 5853, Calif. Acad. Sci., Ent.) on slides collected by the writer at GUSIKA, 15 miles north of FINSCHHAFEN, N. E. NEW GUINEA, April 16, 1944.

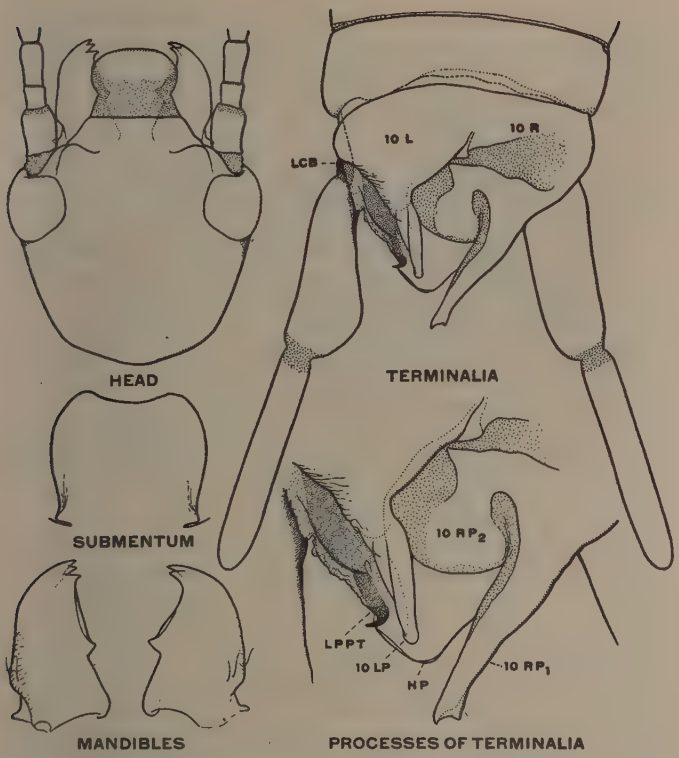

Figure 4. *Oligotoma maritima*, new species. Salient characters of holotype male. Explanation of symbols on page 98.

Paratypes: Twelve males (eleven on slides, one in alcohol) and a series of females on slides and in alcohol, all collected at the type locality during April and early May, 1944. Deposited in the U. S. National Museum, Museum of Comparative Zoology, Harvard, British Museum (Natural History), and in the writer's collection.

Biology: This species was found exclusively on the bark of dense low scrubby trees growing on coral sea cliffs. A few yards inland populations of the species disappeared. The colonies were found in the heavy shade on the outside smooth surface of the bark as well as in bark crevices. Often the colonies were very extensive and formed dense mats of silk that could be peeled off of the bark.

Relationships: Discussed under *aurea*.

(6) Oligotoma hollandia Ross, new species

Male. General color: head blackish-brown contrastingly darker than remainder of body, body, legs, and wings rather uniformly light brown, abdominal terminalia dark brown. *Dimensions:* small, body length 6.6 mm., forewing length 4.7 mm., breadth 1.3 mm.

Head with form as illustrated. Cranium blackish-brown throughout except along margins of occipital foramen where it is pale brown; foramen acutely triangulate in outline; gular bridge width one-third shorter than submentum length. Eyes large with prominent facets. Antennae with basal segment dark brown, second segment medium brown, remainder pale brown becoming somewhat darker distad, seventeen segments present in both antennae (probably incomplete). Labrum medium brown; mandibles with structure as figured, distal half golden-brown, basal half dark brown; palpi medium brown; submentum blackish-brown, outline as figured.

Thorax without specific structural features, light brown with pleurites and anterior promontory of scutae of pterothorax darker brown. *Legs* with all segments rather uniform light brown. Wings without specific venational features; light brown; unpigmented intervenal stripes averaging in width one-third the distance between veins, margins irregular.

Abdomen light brown with unpigmented medial area on tergites. *Terminalia* with structure as figured; tenth tergite dark brown; left process golden-yellow, right processes dark brown except extreme apex of 10 RP_1 which is golden yellow; ninth sternite (H) medium brown; left paraproct (LPPT) sclerotic, dark brown; left cercus-basipodite (LCB) dark brown, apparently fused to left cercus; cerci uniformly pigmented medium brown.

Female (in alcohol): body sclerites light brown with pale tan membranes, head dark brown, legs unicolorous. Length 8.0 mm.

Head with cranium dark chocolate-brown with two lighter suffused areas extending from eyes to middle third; ventrally medium brown, gula and margins of occiptal foramen tan. Antenna with basal segment medium brown, others becoming lighter and tan distad. Mouthparts except mandibles light brown; submentum concolorous with venter of cranium.

Thoracic tergites light brown, pleura, sternum and legs pale tan.

Abdomen with tergites light brown at base but becoming medium brown caudad; sternites except paragenitals practically unpigmented pale tan; eighth sternite uniformly medium brown, ninth sternite slightly darker, cerci medium brown.

Holotype male (No. 5855, Calif. Acad. Sci., Ent.) and *allotype* female (No. 5856, Calif. Acad. Sci., Ent.) on slides collected by the writer at PIE BEACH, HUMBOLDT BAY (NEAR HOLLANDIA), DUTCH NEW GUINEA, May 23, 1944.

Paratypes: Eight males (seven on slides, one in alcohol) and a series of females on slides and in alcohol, all collected with the

holotype and allotype. Deposited in the U. S. National Museum, Museum of Comparative Zoology, Harvard, the British Museum (Natural History), and in the writer's collection.

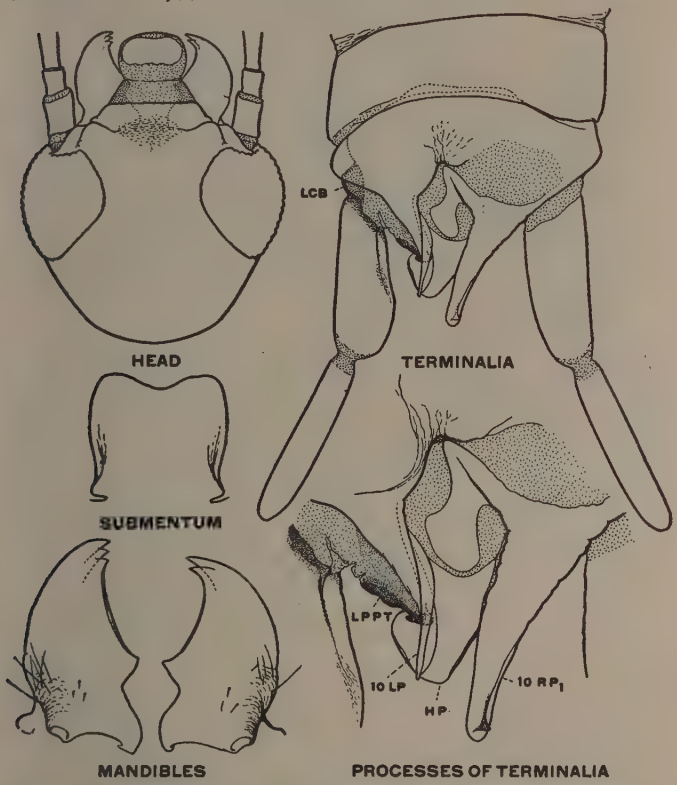

Figure 5. *Oligotoma hollandia*, new species. Salient characters of holotype male. Explanation of symbols on page 98.

Biology: The above specimens were collected during a brief stop on a very small rocky island connected with the mainland at low tide. The vegetation was native garden and secondary jungle scrub and the specimens were collected in the numerous colonies spun in bark crevices of coconut palms and breadfruit tree trunks. Females of a second and larger species were collected on the same island but no associated males were obtained. Its color indicates that it is *mandibulata*.

Relationships: Discussed under *aurea*.

(7) Oligotoma aurea Ross, new species

Male. General color: strikingly bicolorous. Head and wings blackish-brown and brown respectively in strong contrast to the body and legs which are pale golden-yellow. *Dimensions:* body length 8.6 mm., forewing length 5.7 mm., breadth 1.6 mm.

Head with form as illustrated. Cranium blackish-brown throughout except for a pale border around occipital foramen; foramen acutely triangulate in outline; width of gular bridge one-third shorter than submentum length. Eyes relatively small with small facets. Antennae with basal segment dark brown, second medium brown, segments III to X golden-yellow; remainder medium brown, becoming darker distally; number incomplete. Labrum dark brown; mandibles dark yellowish-amber with inner margins of apical half reddish-amber, basal margins dark brown; palpi medium brown; submentum same color as cranium but with lateral margins becoming pale brown, outline as figured.

Thorax without specific structural features; pale golden-yellow throughout, pleurites and anterior promitory of scutae of pterothorax slightly darker. Legs with all segments pale golden-yellow; terminal tarsal segments becoming tan. *Wings* without specific venational features; dark brown; unpigmented intervenal stripes very narrow, about one-tenth the distance between veins in width.

Abdomen pale golden-yellow except at apex. *Terminalia* with structure as figured; tenth tergite pale brown with posterior margins of hemitergites dark brown, left process dark brown at base becoming amber-yellow distad, right process (10 RP_1) dark brown except at extreme apex where it is amber-yellow, secondary process (10 RP_2) medium brown basally, pale yellowish-brown distally; ninth sternite medium brown, process (HP) yellowish; left paraproct (LPPT) medium brown, terminal sclerotic portion dark brown; left cercus-basipodite (LCB) very dark brown, apparently fused to base of left cercus; basal segment of left cercus medium brown with inner and basal margins dark brown, terminal segment light brown; right cercus light brown.

Female (in alcohol) with structure and coloring of *hollandia* but with pigmentation a degree darker. Suffused pale areas of cranium more extensive and nearly merging at middle and with a third inconspicuous small pale area within fork of postfrontal suture. Prothorax yellowish, paler than remainder of body. Length 10.0 mm.

Holotype male (No. 5857, Calif. Acad. Sci., Ent.) and *allotype* female (No. 5858, Calif. Acad. Sci., Ent.) in alcohol collected by the writer on Liki Island, Dutch New Guinea, August 18, 1944.

Paratypes five males and numerous females from Liki Island, August 18-20, 1944; fifteen males and twenty females, on slides and in alcohol from Wakde Island, May and June, 1944; and one male from Toem, Maffin Bay, September, 1944. Deposited in the U. S.

National Museum, Museum of Comparative Zoology, Harvard, the British Museum (Natural History), and in the writer's collection.

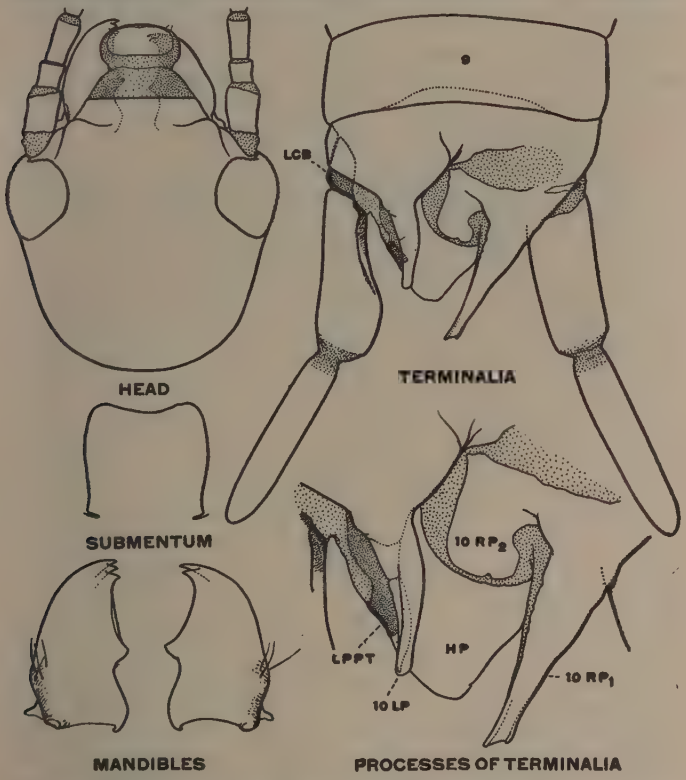

Figure 6. *Oligotoma aurea,* new species. Salient characters of holotype male. Explanation of symbols on page 98.

Biology: In spite of a careful search, only one specimen of this species was collected on the mainland. All other specimens were collected on Wakde Island (2½ miles off the coast from Toem) and Liki Island (about 20 miles north of Maffin Bay), where they were very abundant on the bark and in bark crevices of coconut palms. On Wakde Island the specimens were apparently unharmed by several days of intensive bombing and artillery fire which had leveled most of the cocoanut palms of the island about forty-eight hours before they were collected. The specimen from Toem was collected in an individual colony on the bark of a forest tree.

Relationships: Aurea, hollandia, and *maritima* form a very natural species group with almost identical terminalia structure, similar color tendencies, and similar biology. Sharp distinctions are found however in size, eye and cranial form and in color. These differences are constant in the series of each species.

(8) Oligotoma mandibulata Ross, new species

Male. General color: head dark brown, body and wings medium brown, legs medium brown except coxae and trochanters of mid and hind legs which are whitish. *Dimensions:* medium sized; body length 8.0 mm.; forewing length 5.2 mm, width 1.4 mm.

Head with form as figured. Cranium dark reddish-brown except for whitish area bordering occipital foramen and posterior margins of eyes ventrally; foramen obtusely angulate anteriorly; gular bridge as wide as submentum length. Eyes very large, inflated; facets prominent. Antennae with basal segment concolorous with cranium, second segment medium brown, remaining segments light tan. Labrum medium brown; mandibles with characteristic structure as figured, color golden-yellow with inner margins reddish-amber, outer angles pronounced, rugose, and brownish; palpi light brown; submentum uniformly dark brown.

Thorax structure as throughout the genus; light brown with pale, transverse area between meso- and metathorax and metathorax and abdomen. Prothoracic legs unicolorous light brown. Meso- and metathoracic legs light brown but with coxae and trochanters whitish. *Wings* with oligotomoid venation; color uniform, medium brown; intervenal unpigmented stripes narrow, their width one-fifth the distance between veins, margins regular but not sharply defined.

Abdominal terminalia with structure as figured; tenth tergite and processes medium brown, left process (10 LP) somewhat yellowish with a characteristic subterminal, minute outer spine; ninth sternite light brown, process (HP) nearly colorless; left paraproct (LPPT) medium brown, sclerotic terminal portion amber-brown; left cercus-basipodite (LCB) dark brown; cerci light brown.

Female (in alcohol) blackish brown except for whitish areas between thoracic segments and on leg segments. Length 8.5 mm.

Head with cranium blackish chocolate-brown with suffused paler area at each anterior tentorial pit and closely encircling eyes; ventrally with margins of occipital foramen, gula, and crassae pale brown. Antennae with all segments dark brown, intersegmental membranes whitish; 20 segments present (incomplete). Labrum dark brown; other mouthparts (except mandibles and submentum) dark to medium brown, submentum dark chocolate-brown.

Thorax blackish brown; with membranous areas and acrotergites between thoracic segments creamy white, pale condition continuing ventrally between meso- and metasternum only; pleurae blackish-brown; venter dark reddish-brown. Prothoracic legs with all segments as dark as thorax except tarsi which are medium brown, joint

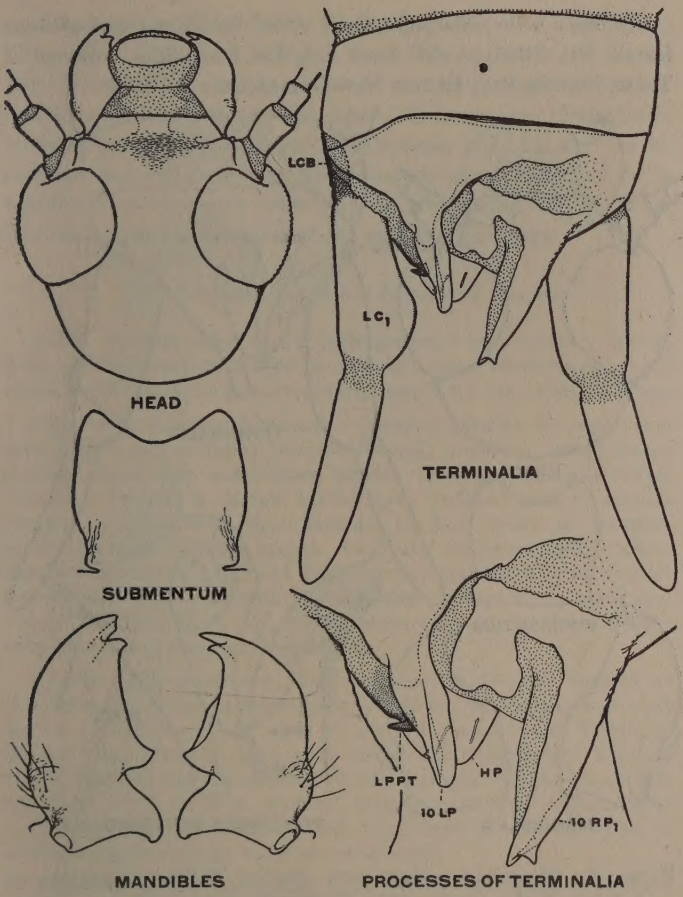

Figure 7. *Oligotoma mandibulata*, new species. Salient characters of holotype male. Explanation of symbols on page 98.

between femur and tibia white; other legs with femora as dark as thorax, tibiae somewhat lighter with basal fourth white, tarsi with basal segment brown and terminal segments tan, coxae and trochanters creamy white.

Abdomen with all tergites blackish-brown with posterior margins reddish-brown, membranes tan. Pleurites and sternites medium brown, membranes tan; eighth sternite with dark lateral areas; ninth sternite except for quadrate basal excision, dark chocolate-brown; cerci and paraprocts dark chocolate-brown.

Holotype male (No. 5859, Calif. Acad. Sci., Ent.) and *allotype* female (No. 5860), Calif. Acad. Sci., Ent.) on slides, collected at TOEM, MAFFIN BAY, DUTCH NEW GUINEA, July 20, 1944.

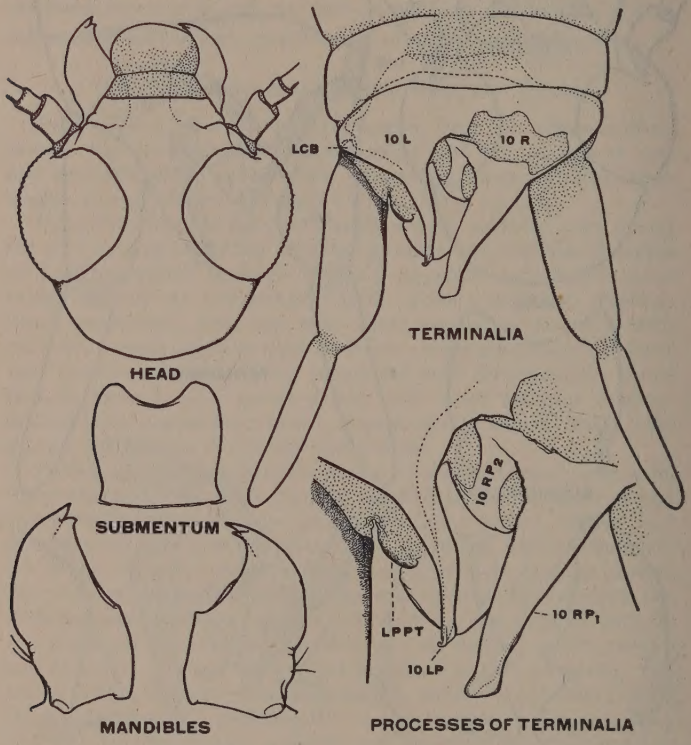

Figure 8. *Oligotoma oculata,* new species. Salient characters of holotype male. Explanation of symbols on page 98.

Paratypes six males on slides and one in alcohol, five females on slides and eight in alcohol, all collected at Toem, June to September, 1944. Deposited in the U. S. National Museum, Museum of Comparative Zoology, Harvard, the British Museum (Natural History), and in the writer's collection.

Biology: Usually found in individual nests spun in the bark crevices of coconut palms planted in groves but also collected on breadfruit tree bark and that of trees in virgin forest. Females apparently of this species were also collected at Humboldt Bay and near Finschhafen.

Relationships: Mandibulata stands apart from the other known New Guinea species by virtue of the following distinctive characters of the male: the deeply and acutely excised mandibles, the two apical teeth of the left mandible fused, the minute but distinct subterminal tooth of the left hemitergal process (10 LP), and the bicolorous mid and hind legs. The female may be recognized by its uniform blackish-brown color with the contrasting whitish coxae, trochanters, and tibial bases of the mid and hind legs.

(9) Oligotoma oculata Ross, new species

Male. General color: head dark brown, wings medium brown, body and legs various shades of medium brown. *Dimensions:* very small, body length 6.0 mm.; forewing length 4.5 mm., width 1.4 mm.

Head with form as illustrated. Cranium dark brown with setae relatively large; occipital foramen obtusely angulate; gular bridge slightly wider than submentum length. Eyes exceptionally large, separated by only a narrow cranial area, inflated with prominent facets. Antennae with basal segment as dark brown as cranium, second segment medium brown, remaining segments light brown; number incomplete. Labrum dark brown; mandibles with characteristic structure as figured; golden-yellow except along inner and apical margins which are reddish-amber; palpi medium brown; submentum and cranium concolorous.

Thorax with prothorax relatively small, otherwise formed as throughout the genus; color medium brown, prothorax somewhat darker. Prothoracic legs with all segments concolorous with prothorax; pterothoracic legs with coxae and trochanters whitish, other segments medium brown. *Wings* without specific venational features; color uniform medium brown, intervenal unpigmented stripes narrow, about one-seventh the distance between veins in width, margins regular and sharply defined.

Abdomen, except terminalia, light brown; terminalia with tenth tergite broadly produced beneath ninth tergite as an apodeme; left hemitergite (10 L) medium brown with dark brown inner and outer margins, process (10 LP) golden-yellow; right hemitergite (10 R) light brown, major process (10 RP_1) dark brown with apical third golden, secondary process (10 RP_2) very dark brown—especially at base; ninth sternite and process light brown; left paraproct (LPPT) unpigmented at base and only slightly so at apex—practically obsolete; left cercus-basipodite (LCB) and basal ring of left cercus very dark reddish-brown; except for dark inner margin of basal segment of left cercus, all segments of cerci are light-brown.

Female (in alcohol) blackish-brown except for contrasting whitish band between meso- and metathorax and certain whitish leg segments. Length 6.5 mm.

Head with cranium rather quadrate, blackish chocolate-brown with two large suffused pale areas between eyes and limited anteriorly by postfrontal suture; ventrally somewhat lighter chocolate-brown. Antennae with basal segment medium brown, other segments pale tan; 17 segments present (incomplete). Mouthparts, except mandibles and submentum, medium brown; submentum as dark as venter of cranium.

Thorax blackish chocolate-brown except for conspicuous creamy white band encircling area between meso- and metathorax. Prothoracic legs more or less unicolorous dark brown; other legs with only femora dark brown, all other segments creamy white.

Abdomen blackish chocolate-brown throughout, ninth sternite nearly black, cerci reddish-brown.

Holotype: male (No. 5861, Calif. Acad. Sci., Ent.) and *allotype* female (No. 5862, Calif. Acad. Sci., Ent.) on slides taken by the writer at ARARA, MAFFIN BAY, DUTCH NEW GUINEA, June 27, 1944.

Paratypes five males and seven females on slides from the type locality but matured in June. Deposited in the U. S. National Museum, Museum of Comparative Zoology, Harvard, the British Museum (Natural History), and in the writer's collection.

Biology: This minute species was collected in individual colonies spun inconspicuously among lichens and moss on the trunks of large trees or under exfoliating bark flakes of basally-buttressed, large trees. Both situations were in a dark, heavily shaded coastal rain forest about 300 yards inland from a sandy ocean beach.

Taxonomic remarks: Oculata is one of the most distinctive of the New Guinea species collected. Its minute size, massive eyes, mandibles without inner-basal excisions and with fused apical teeth (left mandible only), unsclerotized left paraproct, unclavate left cercus, and the distinctive processes of the tenth abdominal tergite all serve to distinguish the male. The female is readily recognized by the unique coloration of the mid and hind legs, i.e., the unpigmented coxae, trochanters, tibiae, and tarsi which are strongly contrasted by the dark brown femora.

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